Mineral Development in Ontario North of 50°

Technical Paper #5

Copper

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the ROYAL COMMISSION on the NORTHERN ENVIRONMENT

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However, no opinions, positions or recommendations expressed herein should be attributed to the Commission; they are solely those of the authors.

COPPER

INTRODUCTION

If there is a metal among metals without which mankind will function least, then, this metal must be copper. This is one of the major impressions obtained at the end of this exercise - the purpose of which was to explore the history of the development of the consumption and production of copper and its prices over the period from 1950 to 1979 with the aim to predict their values up to the year 2004.

The consumption of copper will keep the copper mines of the world busy as mining output will more than double over the production level of 8 million metric tons of 1977. In addition the following analysis will show volume and distribution of refined copper consumption and mine production by main consuming and producing countries respectively. It will also demonstrate Canada's very favourable international trade position of copper not only in real volumes of exports and imports of copper products but also in monetary terms. The analysis will also bring forth that there is not and will not be any shortage of copper reserves now and in the future. Massive investments measuring about $25 billion in copper mining and processing facilities are underway to assure that the challenge of the year 2000 will be met, though not without a substantial though reasonable rise in the real price of copper regardless of circumstances. For Ontario

it means that its production by that time could be expected to be more than 600,000 metric tons of copper annually.

It has also been observed that a number of copper consuming countries, especially those which import most of the copper they consume, try very seriously to substitute copper imports by promoting domestic mining of copper, be it in South America, in Europe or in the Middle East. Such endeavours once successful may affect the operation of the present copper exporting countries but this type of competitive pressure will only modify - if at all - the rate of expansion of production without any change in the direction.

The analysis is organized in the following way: Section I introduces the metal and discusses its properties, qualities, occurrences and possible substitutes. The consumption of copper is explored in Section II which addresses itself to the consumption pattern in the United States and to world copper consumption in total and by geographic regions with the country analysis reserved in the tables of the appendix to this chapter. Section III centers on copper mine production in the world, Canada and Ontario and on its global distribution by main producing countries. This section also examines the Canadian copper trade as well as the world capacities to smelt, to refine, and to distribute their copper. Section IV is of special significance. For one, it explores the sizes of short and long-run copper reserves in the world and their distribution by

resource holding countries or regions. However, for another, it also makes the attempt to assess, on a country-by country basis, the massive copper investments of the world as planned or actually carried out. This very extensive investigation makes it the disporportionately largest section of the study of all metals.

The future of copper prices, supply and consumption, as predicted by the econometric analysis, is presented in Section V with summary and conclusions to follow.

SECTION I: THE METAL

Properties, qualitities, occurrence, usefulness and substitutes

Copper, like gold and silver, is an isometric mineral and a metal element and of a salmon-pink reddish brown colour.[1] Likewise, it is very soft, ductile and very tenacious. In contrast to all other precious metals, however, it occurs in relative natural abundance; yet, it is still scarce enough to fulfil a monetary function as it is used in coinage. Unfortunately, it tarnishes, oxidizes and thus easily dulls, and when left in the open, it adopts a greenish colour called green verdigris. This green deposit is a copper carbonate formed on copper, bronze and brass surfaces which is a salt protecting the metals from further oxidization.

Copper is mainly found in carbonate, oxides and sulfide compounds in almost all 'corners' of the earth, mostly in mineral deposits of relatively low ore quality. Due to its high degree of both ductibility and tenacious malleability, it is, after silver, the best conductor of heat and electricity. Thus, modern power stations, generators and transmission lines as well as the entire telecommunications system is unthinkable without this metal called copper. It is important in the construction industry, in transportation, for ammunition and in jewelry and pigments.

Copper is also used in alloyed form with other metals: one of the oldest known to man is brass, a zinc-copper alloy: another important one is bronze which is an alloy formed wholly or chiefly of copper and tin in variable proportions. Both bronze and brass

are the economically most significant joint products of copper and take the form of sheets, rods, mechanical wires and tubes to be used as inputs into the production of a large variety of intermediate and final consumer products. As to consumer products one could easily recall highly visible items ranging from brass faucets via door frames to musical instruments. Obviously, copper, through its wide range of applications, has turned out to be one of the most essential base metals known to men.

Copper is subject to substitution in various ways. In the electrical field, it meets aluminum as a very strong substitute. Steel shell casings may replace copper-based alloys while plastics are increasingly displacing copper in plumbing. However, it is fair to say that even if these materials substitute copper in some of its functions they still cannot match the outstanding physical properties which are at the root of fame of the red metal.

SECTION II: CONSUMPTION

Basic Input-User Pattern: U.S.A.

The primary and secondary raw copper leaves the refineries in mainly five different forms: cathodes, wire bars, ingots and ingot bars, cakes and slabs, and billets. They represent the inputs of the various users such as wire and brass mills.

Table 1 presents a picture of how the copper users drew on these different forms of refined copper in the U.S.A. for the selected years from 1974 to 1978. Total annual inputs varied during this five-year period. From a relatively high consumption of 1.98 million metric tons, copper inputs dropped to 1.39 million metric tons in 1975. A recovery started in 1976 which continued until 1978 when 2.18 million metric tons of copper refinery shapes were absorbed by their users.[3]

It is of interest to note that the relative importance of cathode copper increased dramatically during this period. From an input proportion of 26.4 percent cathode copper rose in importance by more than 20 percentage points to 47.1 percent, while the input shares held by other forms declined accordingly. Especially, wire bars were affected. They had counted for more than 50 percent of these copper input forms at the beginning of this short period. They were reduced to 37.2 percent. In short, these statistics reveal a distinct preference for cathode copper by copper users.

This shift towards the large demand for cathode copper could be explained through a technological change: the Southwire

Table I

Refined Copper Consumption in the U.S.A. from primary and secondary sources by Type of Consumer and Type of Product used for the Years 1974 - 1978 (percentages)

	Wire Mills	Brass Mills	Second. Smelter	Found-ries	Misc.	Consumption in metric tons	Cath-odes	Wire Bars	Ingots & Bars	Cakes Slabs	Billets	Other
1974	67.2	30.5	0.4	0.9	1.0	1,980,675.4	26.4	51.8	6.5	8.1	6.3	0.8
1975	69.2	28.6	0.3	0.9	1.0	1,385,200.3	32.0	50.0	6.0	6.4	5.0	0.7
1976	68.5	29.4	0.4	0.8	1.0	1,798,074.5	43.2	39.8	5.8	6.1	4.2	0.9
1977	69.7	28.5	0.1	(1 . 7)		1,969,723.8	45.0	38.9	4.0	5.2	4.7	0.5[1)]
1978	70.9	29.0	0.2	(?)		2,126,711.5	47.1	37.2	4.5	5.5	5.3	0.3

including 1.5 percent for foundries and miscellaneous users

Source: American Metal Market, Metal Statistics 1979, New York, N.Y., p. 81.

1) incomplete data as information was withheld to avoid disclosing of company confidential data. Sum of percentage by type of use for 1977 is 98.3% to which the previous 1.7 - in brackets - have to be added to make 100%.

Process. Instead of transforming cathode copper into wire bars which have to be rolled for wire drawing, this new process operates a new furnace with associated casting and wire-drawing facilities. It is a continuous process which utilizes cathode copper directly and delivers copper wire products of a better quality as fewer impurities are contained in the product. Therefore, wire mills, which formerly relied on the wire bars, to avoid the transformation process can now avail themselves of cathode copper if they have adopted the new technology.[4]

The two outstanding users of copper are wire and brass mills. The lion's share of copper inputs is consumed by wire mills which betray a rising trend in copper usage compared to the brass mills. If one bears in mind that copper alloys require chiefly copper scrap[5], the increased preference for cathode copper falls upon no other than the wire mills.

World Consumption

The annual consumption of refined copper in the world rose from 2.64 million metric tons to 9.97 million metric tons between the years 1950 and 1979. This is an increase of 270.5 percent between the two years or a rise by a factor of 3.7.

When taking the averages of copper consumption for the first and for the last five-year periods, the rate of increase is 209 percent or by a factor of about 3.1. This means simply that world consumption during the period under investigation more than tripled. Only in one year did a huge drop in world copper consumption occur. This took place in 1975 when consumption fell by 930,000 metric tons; but it did recover immediately in

Table 2

World Consumption of Refined Copper and Ratio (Percent)

Of Mined Copper to Consumption

For The Years 1950 to 1979

Year	World Consumption in '000 of metric tons	Direction of change	Percentage of Mined Ore (metal content) to consumption
1950	2642.8		93.5
1951	2811.9	+	92.7
1952	2907.8	+	92.3
1953	2808.4	-	97.4
1954	3112.2	+	90.3
1955	3513.2	+	87.2
1956	3602.1	+	93.3
1957	3596.1	-	97.2
1958	3658.4	+	92.4
1959	3783.2	+	97.3
1960	4244.1	+	97.1
1961	4562.2	+	96.5
1962	4553.9	-	99.5
1963	4809.0	+	96.4
1964	5445.3	+	89.3
1965	5633.5	+	90.4
1966	5971.6	+	89.6
1967	5262.5	-	95.8
1968	5890.4	+	95.4
1969	6402.9	+	94.6
1970	6638.2	+	97.9
1971	6523.7	-	100.6
1972	6937.8	+	103.1
1973	8487.9	+	89.4
1974	8360.4	-	93.1
1975	7430.0	-	99.5
1976	8508.0	+	92.5
1977	9000.6	+	88.8
1978	9440.8	+	83.9
1979	9792.8	+	80.8

Source: United Nations, Statistical Yearbook, "Extractive Industries", New York, N.Y. ABMS., Non-ferrous Metal Data, 1979, New York, N.Y.

the following year with a rise by 1,098,000 metric tons.

The annual consumption values are set out in Table 2. They indicate both the continuity of the rising trend and some type of cyclicality as may be seen from the sequence of the positive and negative signs in the same Table. Usually, three and four years of rising annual consumption are followed by one year during which the demand for copper is smaller. These changes find further reflection in the ratio of mined to consumed, refined copper (Table 2). During times of reduced consumption the ratio obviously increases. In two specific years, it even exceeded one hundred percent. However, normally, less copper is mined in the world than is finally consumed. These differences express the degree to which copper consumers tend to rely on recycled, secondary copper;[6] and it seems that the world utilizes relatively more copper scrap now than it did 25 to 30 years ago.

World Copper Consumption by Region

America

In the year 1950 the American region consumed 52.5 percent of the world's refined copper. By 1979, this share had been reduced to 29.5 percent in spite of the 108.4 percent increase in annual consumption as brought out in Table 3. The U.S.A. held 46.8 percent in 1950 against its 22.6 percent 30 years later. Its copper usage had just increased by 78.5 percent. The performance by the main consuming countries of the American continents are set out in Table A1 in the appendix to this chapter.

Table 3

World Consumption of Refined Copper (metric tons) and Distribution by Region and Main Using Country For the Years 1950 and 1979

	1950	%	1979	%	% Δ 1979:1950
Total America	1386.8	52.5	2890.5	29.5	108.4
Total Europe	885.1	33.5	2904.3	29.7	228.1
Total Asia	95.9	3.6	1550.8	15.8	1517.1
Total Africa	17.5	0.6	84.9	0.9	385.1
Total Australasia	17.8	0.7	125.9	1.3	607.3
Total centrally planned economies	239.8	9.1	2236.3	22.8	832.6
Total World Consumption metric tons ('000)	2642.9		9792.7		270.5

Canada, with a 153.2 percent increase in annual copper usage,held 2.5 percent in 1979 after it once had held a share of 3.5 percent. The most interesting point may be brought out for Mexico, Argentina, Brazil and, to some degree, for Chile. These four countries raised their shares of the industrial use of copper from 2.0 to 4.1 percent of the world's total. Argentina increased its annual absorption of the red metal by 1,720 percent, Brazil by 960 percent, and Mexico by 909 percent. Only Chile's expansion was not as rapid. Its annual copper utilization expanded by almost the same rate as Canada's. However, in light of the flourishing free-market economy in today's Chile, this rate may rise substantially in the years to come!

Europe

In 1950 Europe absorbed 33.5 percent of all copper in the world (Table 3). By 1979, this share had declined to 29.7 percent although Europe consumed 228.1 percent more copper then than in 1950. It was the United Kingdom which, in that early period, was the greatest copper user of Europe (Table A2) when it needed 12.8 percent of the world's total. By 1979, its share had declined to 5.1 percent, although its absolute copper demand had expanded by 46 percent.

By then, Western Germany had taken first place in Europe handling industrially 8.5 percent of the world's copper (Table A2). In 1950, it had been in second position with 6.8 percent. In retrospect, copper consumption rose by 360 percent in Western Germany!

France remained third in line as she raised her copper input by 202 percent. Her relative share diminished from 4.3 percent of the world's total in 1950 to 3.5 percent in 1979. Belgium and Italy were almost tied for fourth place in 1979 compared to the 2.2 and 2.3 percent respectively held in 1950. Belgium's annual copper need improved by 444 percent while Italy's climbed by 392 percent during this period of time.

Finally, there are the industrially developing countries of Europe: Portugal, Spain and Yugoslavia to which one has to add the centrally-planned countries of Poland and Czechoslovakia. Although the statistics are inconclusive as regards the total copper consumption of the latter two, all these countries seem to display exceptionally large changes in consumption rates: The former three showed copper consumption spurts of 2,535 percent for Portugal, 1,497 percent for Spain and 1,008 percent for Yugoslavia. Their relative shares, totally insignificant in the 1950s testified to the fact that, in 1979, they were important copper users in the world.

Asia

It is not surprising to find Asia as the region with the greatest regional rate of increase in annual copper absorption; it rose by 1,517 percent (Table 3) over the period under investigation. Its world copper consumption share expanded from a mere 3.6 percent to 15.8 percent.

The country most responsible for this outstanding feat is Japan. Its copper share alone rose from 2.4 percent in 1950 to 13.2 percent of the world total in 1979. During this period

of time the annual consumption increased by 1,937 percent (Table A3). The other Asian countries combined, i.e., Iran, the Philippines, the Republic of Korea, Taiwan, Turkey and China took the remainder of the enlargement of the share. These countries raised their combined demand for copper by 9,037 percent as their joint share went from 0.2 percent to 5.9 percent on the world copper scene.

Africa

The information on Africa is scarce and inconclusive. By consuming not even one percent in 1979, this huge continent with its very large population will not fail to expand the industrial usage of copper dramatically in the years to come when industrialization gains firm roots in its many developing countries. What has been said for the prospects of these developing countries in the discussion of the consumption of nickel[7] holds easily true for copper, zinc and lead. Therefore, this argument should not be repeated here.

Australasia

From 0.7 percent of the world's copper consumption, this region's use of the red metal grew in such a way that it held 1.3 percent of the world total in 1979 (Table 3). Annual consumption between 1950 and 1979 displayed an increase of 598 percent, a very remarkable expansion indeed.

In 1979 Australia used 124,211 metric tons of copper while New Zealand, for which earlier statistics are difficult to access, absorbed 1,761 metric tons of that metal. This is equivalent to 0.018 of one percent of the world total. New Zealand remains

an insignificant industrial user of copper (Table A5).

Centrally Planned Economies

According to Table 3, these countries enlarged their annual copper utilization by 832.6 percent between the two specified years. In 1950, they took 9.1 percent of the total. By 1979, their copper consumption was 22.8 percent. This is in itself an expression of a very rapid industrialization taking place in this particular region. Naturally, not everything is known what one would like to know for a more complete study. However, as far as could be ascertained, the most important country, not unexpectedly, is the Soviet Union. From a world share of 8.31 percent in 1950, it climbed to 13.5 percent as its demand for copper rose from 219,627 metric tons in 1950 to 1,323,268 metric tons 30 years later (Table A6).

Eastern Germany held 1.2 percent in 1979, while Rumania's and Albania's shares were estimated at 0.6 and 0.06 of one percent respectively. For the other countries such as Bulgaria and Hungary not much material for comparative evaluation is easily available; it is not even certain that it would be significant[8]. Poland and Czechoslovakia had been peripherally included in the discussion of Europe, that is in regard of Table A2 in the Appendix. In short, they appear to remain insignificant consumers of copper in the world.

The following breakdown gives the rank of the copper consumers in the centrally planned economies as well as the

respective shares which they hold in the world copper consumption picture.(1979)

Rank	Country	World Share (%)
1.	U.S.S.R.	13.51
2.	China and Other Asia	3.82
3.	Poland	1.88
4.	Eastern Germany	1.21
5.	Czechoslovakia	0.87
6.	Rumania	0.65
7.	Bulgaria	0.59
8.	Hungary	0.25
9.	Albania	0.06

SECTION III: PRODUCTION

This section investigates the copper mine production in the world, in Canada and in Ontario over the study period. It further explores the copper output by chief copper mining countries and it tries to analyze briefly the Canadian copper trade. At the end the attempt is made to obtain some perspective of conditions, changes and distribution of smelting and refinery capacities in part of the world between the years 1955 and 1979; admittedly, this attempt does not lay claim to be all-inclusive!

Copper Mine Production: World, Canada and Ontario

World

There are about 55 countries in the world with copper mines. They increased their annual output by 220 percent between 1950 and 1979. In 1950, output amounted to 2.47 million metric tons compared to 7.91 million metric tons 30 years later.[9] In terms of the averages of the first and last five years,copper mining saw a rise of 194 percent as these averages advanced from 2.66 to 7.82 million metric tons.

As Table 4 and Figure 7 of Chapter I show, the rise was steady accompanied by a certain cyclicality. As a matter of fact, output reached an even 8 million metric tons in 1977, representing the peak for the period under study. A major setback had occurred earlier in 1975 as the annual output declined by 380,000 metric tons over the previous year's. By 1979, output had fallen by 90,000 metric tons or by (-) 1.125 percent below the 1977 production peak.

Table 4

World and Canadian Mine Production of Copper and Percentage Distribution for Canada and Ontario for the Years 1950-1979

Year	'000 metric tons		Percentage of World Output	
	World	Canada	Canada	Ontario
1950	2470[2)]	106.9	4.32	1.90
1951	2605	244.9	9.40	4.49
1952	2685	234.1	8.72	4.24
1953	2735	229.7	8.40	4.33
1954	2810	274.6	9.77	4.54
1955	3065	295.7	9.65	4.33
1956	3359	321.9	9.58	4.22
1957	3495	325.8	9.32	4.46
1958	3380	313.1	9.26	3.81
1959	3680	358.6	9.74	4.64
1960	4120	397.7	9.65	4.53
1961	4406	398.3	9.04	4.36
1962	4534	414.9	9.15	3.78
1963	4637	410.6	8.85	3.50
1964	4865	441.7	9.08	3.69
1965	5090	460.7	9.05	3.85
1966	5350	459.1	8.58	3.44
1967	5050	556.4	11.02	4.96
1968	5620	562.5	10.01	4.59
1969	6060	520.0	8.58	3.57
1970	6500	610.3	9.39	4.12
1971	6560	654.5	9.98	4.18
1972	7150	719.7	10.07	3.68
1973	7590	823.9	10.86	3.43
1974	7780	821.4	10.56	3.65
1975	7400	733.8	9.92	3.46
1976	7870	730.9	9.29	3.31
1977	8000	780.6	9.76	3.60
1978	7920	659.2	8.43	2.49[1)]
1979	7910	643.6	8.24	2.37[1)]

Source: United Nations, Statistical Yearbook, "Extractive Industries", New York, N.Y.
ABMS, Non-ferrous Metal Data, 1979, New York, N.Y.
1) reflecting effects of the strike in Sudbury;
2) UN Statistics, adjusted 1950-1960 U.S.S.R.

Canada and Ontario

Canada started with a copper mine output of 106,900 metric tons in 1950. It jumped to 244,900 metric tons in the following year, after which it rose almost at the same rate as the rest of the world. This is reflected in the relatively stable Canadian share ranging between 8.40 and 9.77 percent for the period 1951-1966. In the years to follow, Canadian copper mines gained on the rest of the world when that Canadian share climbed to 11.02 percent in 1967. It held its position by supplying more than 10 percent of the world's mined copper well until 1974. Only 1969 recorded a minor setback.

After 1975, however, Canada's importance as a copper mining country started to subside. Especially the years 1978 and 1979 seem to bring out this point (Table 4). However, the cutbacks in the nickel industry of which copper is a co-product and a prolonged labour dispute in the Sudbury Basin contributed substantially to the reduced mine output. This is especially visible in the smaller percentage recorded for Ontario. Copper mining in Ontario had always stood between 3.31 percent (1976) and 4.96 percent (1967) as the highs and lows of the world total which Ontario held between 1951 and 1976. Therefore, the sharp drop-off for 1978-1979 is mainly attributable to the events in Ontario. It also demonstrates that INCO, where the strike occurred,is not the only copper producer in Ontario, and thus, in Canada,[10] because Ontario's and Canada's shares were still greatly significant in world terms.

The Main Copper Mining Countries of the World

Of the more than 55 copper mining countries 19 have been selected as relatively large producing units. They account for about 90 percent of the world total while the other 36 take the remaining 10 percent to their credit.

The largest copper producer in 1979 was still the United States with 18.2 percent of the world total. This represented a significant, relative decline considering that in 1950 the U.S.A. mined one third of the world's copper.

In 1950, the second largest copper producer had been Chile (14.7%) followed by Zambia (11.4%), the U.S.S.R. (8.1%), Zaire (7.1%), and then Canada (Table 5). By 1979, the U.S.S.R. had become the world's second largest copper mining country, with Chile in third place (13.4%) and Canada in fourth position (8.2%); Zambia was fifth (7.4%) and Zaire sixth (5.1%).

During this period of time, some new and significant producers emerged. They were: Australia, which raised its share of the world total from 0.6 percent to 2.9 percent; Peru, which went from 1.2 percent to a full five percent; Poland for which no output had been recorded in 1950 and which commanded a full four percent by 1979. South Africa and Bulgaria are the other two countries which became significant world producers. The former's share rose from 1.4 percent to 2.5 percent, while the latter's position moved from 0.1 to 0.8 percent during that period.

The most abrupt appearance, however, was staged by Papua New Guinea. Until 1972, no copper output had been recorded in the

Table 5

Distribution of World Copper Mining Output by main producing Countries for selected years between 1950 and 1979

in percentages

	1950	1955	1960	1965	1970	1975	1979
Australia	0.6	1.6	2.7	1.8	2.2	3.2	2.9
Bulgaria	0.1*	0.2	0.3	0.6	0.6	0.7	0.8
Canada	4.3	9.7	9.7	9.1	9.4	10.6	8.2
Chile	14.7	14.1	12.9	11.6	10.9	11.2	13.4
China	-	-	-	1.8	1.5	1.3	2.2
Finland	0.7	0.8	0.7	0.6	0.5	0.5	0.6
Indonesia	-	-	-	-	-	0.9	0.8
Japan	1.6	2.4	2.2	2.1	1.8	1.1	0.8
Mexico	2.5	1.8	1.5	1.4	0.9	1.1	1.3
Namibia	0.4	0.7	0.4	0.7	0.4	0.5	0.5
Papua New Guinea	-	-	-	-	-**	2.3	2.2
Peru	1.2	1.4	4.4	3.9	3.4	2.5	5.0
Poland	-**	0.2	0.3	0.3	1.3	3.1	4.0
South Africa	1.4	1.4	1.1	1.2	2.3	2.4	2.5
U.S.S.R.	8.1	10.9	12.1	13.8	14.2	14.8	14.4
U.S.A.	33.4	29.6	23.8	24.1	24.0	17.3	18.2
Yugoslavia	1.8	0.9	0.8	1.2	1.4	1.6	1.5
Zaire	7.1	7.7	7.3	5.7	6.0	6.7	5.1
Zambia	11.4	11.3	13.8	13.7	12.9	10.9	7.4
	89.3	94.7	94.0	93.6	93.7	92.7	91.8

* estimated

** no output recorded prior to 1972

** no record (UN) before 1952

UN statistics. By 1975 and in 1979 it had captured 2.2 percent of the world copper mining share.

In short, on the basis of the 1975 distribution in Table 5, six countries accounted for more than 71.5 percent of the copper mined on earth. Of these Canada was the fifth largest with 10.6 percent. By 1979 standards, 71.7 percent were supplied by seven countries with Canada taking 8.2 percent to its credit.

Canadian Copper Trade

Canada is a strong net exporter of copper. The ratio of aggregate imports to exports was 1/10 in 1977, 1/6.5 in 1978 and 1/6.1 in 1979. Table 6 provides a general insight into the structure of the Canadian copper trade for the years 1977 to 1979. The exports of copper declined during that period of time from 654,783 to 598,378 metric tons. This drop reflects the generally weak production conditions discussed above.

(in metric tons)

Year	Production	Exports	Ratio	Imports	M/X
1979	643,600	598,378	93.0	98,172	1: 6.1
1978	659,200	623,040	94.5	95,649	1: 6.5
1977	780,600	654,783	83.9	65,714	1:10.0

This breakdown describes some of the features of the Canadian trade in copper. In 1977, 83.9 percent of our mine output could be related to the exports of copper. This factor rose as our output declined, reflecting a considerable stability in the demand for the export of Canadian copper (Table 6).

There are five copper commodity items which make up most of Canada's copper exports. Copper ores, concentrates and matte

Table 6

Canadian Copper Export and Import Structure for the Years 1977 - 1979

By Commodity Items

Commodity Description	Commodity Item	Exports			Imports		
		1979	1978	1977	1979	1978	1977
	Volume	598378	623040	654783	98172	95649	65714
Copper in Ores, Concentrates and Matte	253-10	53.20	45.29	42.69	-	-	-
Copper in Slag, Skimmings and Sludge	253-20	0.04	0.01	0.03	-	-	-
Copper Scrap	253-30	2.65	2.71	2.56	27.02	20.86	18.00
Brass and Bronze Scrap	253-50	2.73	3.00	2.53	-	-	-
Copper in Ores and Concentrates	253-39	-	-	-	2.69	19.23	7.01
Copper Alloy Scrap N.E.S.	253-90	1.36	0.90	0.58	-	-	-
Copper Alloy Scrap	253-99	-	-	-	9.08	7.93	5.73
Copper Refinery Shapes	452-04	31.94	39.76	44.94	33.15	22.41	28.64
Copper Bars, Rods & Shapes N.E.S.	452-08	1.94	2.03	1.96	0.81	2.18	3.65
Copper Plates, Sheet & Flat Products	452-12	1.13	1.08	0.94	1.14	1.06	1.39
Copper Pipe and Tubing	452-15	1.62	1.39	1.15	2.43	2.08	3.33
Copper Wire and Cable, not insulated	452-18	0.25	.21	.06	1.74	2.06	2.00
Copper Alloy Shapes and Sections	452-19	2.15	2.33	1.71	-	-	-
Copper Powder	452-23	-	-	-	0.58	.74	.92
Copper Alloy Refinery Shapes, Bars	452-75	-	-	-	10.00	10.39	12.31
Brass Plates, Sheet, Strip, etc.	452-76	-	-	-	4.28	4.59	5.81
Copper Alloy Plates, Sheet, etc., N.E.S.	452-78	-	-	-	1.10	1.10	2.18
Copper Alloy Pipe and Tubing	452-85	0.67	1.00	0.59	2.53	2.60	3.77
Copper Wire & Cable, not insulated	452-88	0.03	0.05	0.05	0.78	0.52	0.90
Copper Alloy Castings	452-90	-	-	-	0.59	0.42	0.52
Copper & Copper Alloy, Fabr.mat. N.E.S.	452-99	0.27	0.23	0.22	2.08	1.81	3.85
		99.98	99.99	100.01	100.00	99.98	100.01

represents the most important of these export items. They accounted for 53.2 percent of all exports! This export category displayed a rising tendency over the last three years with about three quarters going to Japan as explained in Table A7 in the appendix. Norway and the U.S.S.R. are the other importers at about 6-7 percent each. However, it has to be understood that the exports to Norway refer to the Sudbury matte which is produced by Falconbridge Nickel Mines and sent to its refinery in Kristiansand; also note, that it is only in recent years that such copper exports to the Soviet Union have been on the rise.

In contrast, the second most important export item consists of refined copper: copper refinery shapes. Their significance as exports has been on the decline in both relative and absolute terms as shown in Table A14. In 1979, 100,000 metric tons less were exported. The main customers were the United States and the United Kingdom.

When one turns the view towards the import side, one immediately recognizes the rising imports of refinery shapes during those three years. In net terms, Canada exports of refinery shapes decreased by 116,841 metric tons. In short, in the most important areas of the copper trade, the exports of our raw materials, i.e. ores, concentrates and matte, increased, whereas the volume of the refinery products went down.

The next two items to be discussed deal with exports and imports of copper scrap and brass and bronze scrap. Together, they

account for more than five percent of Canada's copper exports and to between 18% and 25% of copper scrap imports. Table A9, which displays the copper scrap picture, tells that a change took place from a positive balance (4,935 metric tons) in 1977 to an excess of imports over exports by (-) 10,652 metric tons in 1979. Almost all of these imports came from the United States, and they certainly must have helped the Canadian secondary refineries at a time when there was some stringency in the Canadian market, as the electrolytic copper refinery at INCO was out of action in 1978/79.

The fifth and last of the major copper export items consists of copper alloy shapes and sections (Table A19). They counted two percent of copper exports averaging 12,852 metric tons for these years. With rising copper prices the values of shipment rose accordingly year by year. The United States, unquestionably, was the most important importer of these Canadian products (Table A19).

The next copper import item of significance is copper alloy refinery shapes and bars (Table A21). The quantity averaged 9,282 metric tons per annum over the three year period of which 79 percent came from the United States.

In addition, a certain amount of copper scrap was imported (Table A13). These imports averaged 6,755.6 metric tons per year almost exclusively coming from the United States. However, if one is to back track, one should not be surprised to find another, quite similar category: viz. copper alloy scrap,

N.E.S. (Table A12). This is purely an export item for it does not appear on the import side of the ledger. On the average, 5,850.6 metric tons were shipped during those years annually. When these two related items were combined, the net balance amounted to an unimportant 905 metric tons of imports of copper alloy scrap.

The overall performance of the Canadian copper trade may be summarily seen and appraised in light of the drawn, financial balance. Considering net exports receipts and net imports payments -- by commodity item -- the financial balances for the year 1977-1979 are as follows:

('000 $ Can)

Year	Net Export Balance	Net Import Payments	Copper Trade Balance
1979	1,025,078	68,398	956,680
1978	748,890	65,743	683,147
1977	768,392	42,518	725,874

Although Canada exported copper items in 1979 to the value of $1.025 billion, it ended up with a net balance of $956.68 million. Compared to the balance of 1978 this meant an improvement of 40 percent; with respect to the accomplishment of 1977 a positive change of 31.8 percent is noticeable. When the balances of 1978 and 1977 are combined --note that 1978 meant a decrease below the return obtained in 1977-- an average increase in net return in the copper trade was 35.8 percent for the year 1979.

Smelting and Refining Capacity

As laid out in Table 7 the distribution of copper smelting capacity in the Western world --excluding the centrally planned economies due to lack of information-- saw the United States on top with 8,130,300 metric tons of dry materials smeltable which would produce a product. This capacity represented 30.74 percent of the recorded total. Canada was second with 7,418,200 metric tons which was equivalent to a share of 28.05 percent. Chile is the third largest copper smelting country in the world holding a capacity of 2,626,000 metric tons or 9.93 percent of this total. Zambia is fourth with 2,310,000 metric tons or 8.73 percent while Peru is the fifth largest copper smelting country in this breakdown with 1,270,000 metric tons or 4.80 percent of this distribution.

It is quite clear that these capacities, more or less, correspond largely to shares of the copper mining output of the various countries. However, this correspondence does not hold for Japan. It produced 59,950 metric tons of copper out of a world production of 7,910,360 metric tons constituting an insignificant part of world production -- including the centrally planned economies. Yet, Japan is the country with the next largest copper smelting capacity: 1,162,320 metric tons or 4.39 percent of the listed total.

Japan is followed by Australia (3.2%), Mexico (2.32%) and South Africa (2.06%). Only Yugoslavia exceeds the one percent significance limit of distribution among all the remaining and

Table 7

Copper Refining and Smelting Capacity for the years 1955 and 1979

By Country of the Mainly Non-centrally Planned Economies

Country	Refining Capacity ('000 metric tons) 1955	1979	% Δ	Smelting Capacity ('000 metric tons) 1955	1979	Distribution Smelt. Cap. 1979 %	Refin. Cap. 1979 %
U.S.A.	1872.46	2664.00	42.3	7689.40	8130.30	30.74	29.64
Canada	315.7	615.00	94.8	8568.50	7418.20	28.05	6.84
Mexico	39.0	71.7	83.8	840.0	614.2	2.32	0.80
Chile	163.3	762.8	367.1	-	2626.00	9.93	8.49
Peru	27.2	199.6	633.8	-	1270.00	4.80	2.22
Austria	10.00	32.0	220.0	-	-	-	0.36
Belgium	145.00	820.0	465.5	-	150.0	0.57	9.12
Finland	24.00	48.0	100.0	-	60.0	0.23	0.53
France	25.00	45.0	80.0	-	- -	-	0.50
W.-Germany	182.0	325.0	78.6	-	30.0	0.11	3.60
Norway	21.9	30.0	37.0	-	9.0	0.03	0.33
Spain	39.0	171.0	338.5	-	139.0	0.53	1.90
Sweden	32.0	64.0	100.0	-	90.0	0.34	0.71
U.K.	241.8	154.0	(- 36.3)	-	-	-	1.71
Turkey	10.0	82.5	725.0	-	12.6	0.05	0.92
Yugoslavia	42.0	150.0	257.1	-	500.0	1.89	1.67
India	8.1	40.6	401.2	-	47.5	0.18	0.45
Japan	125.7	1242.1	888.5	-	1162.3	4.39	13.82
S. Korea	-	50.0	-	-	200.0	0.76	0.56
Namibia	-	-	-	-	72.6	0.27	-
S. Africa	14.2	155.2	989.1	-	544.5	2.06	1.73
Zimbabwe	-	36.0	-	-	36.0	0.14	0.40
(Rhodesia)	285.4	-	-	-	-	-	-
Zambia	-	770.0	-	-	2310.0	8.73	8.57
Zaire	125.0	250.0	100.0	-	160.0	0.60	2.78
Uganda	-	-	-	-	20.30	0.08	-
Australia	40.0	210.0	425.0	-	845.0	3.20	2.34
		8988.5			26447.47	100.00	99.99

Source:ABMS.,Non-ferrous Metal Data, 1979,New York , N.Y.;
----.,Yearbook,1956(1955),New York, N.Y.

listed countries as its copper smelting potential runs at 1.85 percent. The remaining countries, at least in the year 1979, are still of minor importance.

Refining Capacity

An even more interesting picture may be drawn for the capacity of various countries to refine copper. Here, even the growth since 1955 may be included. Again, the United States is in top position with an ability to refine 2,664,000 metric tons of copper. This amounts to 29.64 percent of the registered world capacity and reflects an increase of 42.3 percent since 1955.

However, the second largest refining country is not Canada, but Japan which is able to process 1,242,100 metric tons of refined copper, an amount which is equivalent to 13.82 percent of the total. This is also presented in Table 7. Its refining capacity rose 888.5 percent over that of the year 1955!

The world number 3 refiner of copper is, to many people's surprise, the country of Belgium. It could refine 820,000 metric tons of copper, which is 9.12 percent of the total. This country's refining capacity expanded by 465.5 percent during that period of time. This compares very favourably with that country's smelting capacity totalling 0.57 percent of the world. One could be even more specific: Japan's refinery capacity of 1,242,000 metric tons corresponds closely to its industrial consumption of copper. In 1979, it used 1,302,920 metric tons of refined metal (primary and

secondary copper), whereas Belgium consumed only 314,600 metric tons. In reality, it could refine 2.6 times more than its domestic demand for copper. Chile, on the other hand compares favourably in the sense that it is the fourth largest world copper refiner with a capacity of 762,800 metric tons which reads 8.49 of the distribution and tells of an increase of 367.1 percent during this period of time.

The fifth largest copper refining country is, unquestionably, Zambia. With 770,000 metric tons it counts 8.57 percent of the world refining capacity as its own.

It is only then that Canada appears on the list of refinery rankings as it is sixth in line and able to refine 615,000 metric tons in 1979. This is 6.84 percent of the world total and reflects an increase of 94.8 percent since 1955.

Canada is followed by Western Germany (3.60% vs. only 0.11% of smelting capacity), Zaire (2.78%), Australia (2.34%), and finally, Peru with 2.22%. It is in these ten countries that 87.42 percent of the copper refining capacity is concentrated.

Canadians may raise the question as to where the ores mined in Canada are (a) smelted (b) refined and (c) who sells the final products of the various copper commodity items. In answer to this question, the following Table 8 is inserted which explains the Canadian ore flow to the market in a very concise manner. A considerable amount is smelted and refined in Japan which is not entirely unexpected because it was noted above that Japan purchases 75 percent of Canada's exports of copper ores, concentrates and matte.[11]

Table 8

Canadian Copper Flow From Mine to Market

Company	Where Smelted
ARSARCO Incorporated Buchans Unit	ASARCO, El Paso, Tex.
Bethlehem Copper Corp.	Spain and Other Foreign Countries
Campbell Chibougamau Mines, Ltd.	Noranda, Noranda, Quebec
Consolidated Rambler Mines Limited	Gaspe Copper Mines Ltd., Noranda, Quebec
Craigmont Mines, Ltd.	Japan
Texasgulf Canada Ltd.	Noranda, Noranda, Quebec
Falconbridge Nickel Mines, Ltd.	Own Plant,Falconbridge Ont.
Falconbridge Copper Limited	Noranda, Noranda, Quebec
Noranda Mines Ltd., Gaspe Division	Own Plant, Murdochville, Que.
Gibraltar Mines Limited	Japan
Newmont Mines Limited	Japan
Hudson Bay Mining And Smelting Co., Limited	Own Plant, Flin Flon, Manitoba
Inco Ltd., Canada	Own Plants, Copper Cliff, Ontario
Lornex Mining Corp.	Japan
Madeleine Mines Ltd.	Gaspe Copper Mines Ltd.
Mattabi Mines Limited	Noranda, Noranda, Quebec
Noranda Mines Ltd.	Own Plant, Noranda, Quebec
Noranda Mines Ltd., Mattagami Div.	Noranda, Noranda, Quebec
Orchan Mines, Limited	Noranda, Noranda, Quebec
Pamour Porcupine Mines, Limited	Noranda, Noranda, Quebec
Patino Mines (Quebec) Limited	Noranda, Noranda, Quebec
Sherritt Gordon Mines, Ltd.	Hudson Bay Mining & Smelting Co. Ltd., Flin Flon, Manitoba, Noranda, Noranda, Quebec
South Bay Mines Ltd.	Noranda, Noranda, Quebec
Utah Mines Ltd.	Mitsui Mining And Smelting Co., Hibi Smelter, Japan Dowa Mining Co., Onahama, Japan
Western Mines, Ltd.	Japan

Source: ABMS., Non-Ferrous Metal Data, 1979, New York, N.Y., 1980, p. 26,27.

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Table 8

Canadian Copper Flow From Mine to Market

Where Refined	Sold By
ASARCO, Amarillo, Tex.	ASARCO Incorporated
Spain and Other Foreign Countries	Bethlehem Copper Corp.
Canadian Copper Refiners, Ltd.	Noranda Sales Corp. Ltd.
Canadian Copper Refiners Ltd.	Noranda Sales Corp. Ltd.
Japan	Craigmont Mines, Ltd.
Canadian Copper Refiners, Ltd.	Texasgulf, Inc.
Falconbridge Nikkelverk A/S Norway	Falconbridge-Bermuda, Brussels, Pittsburgh, Toronto
Canadian Copper Refiners Ltd.	Noranda Sales Corp. Ltd.
Canadian Copper Refiners Ltd.	Noranda Sales Corp. Ltd.
Japan	Gibraltar Mines Limited
Japan	Mitsubishi Metal Corporation
Canadian Copper Refiners Ltd., Montreal, Quebec	Hudson Bay Mining And Smelting Co., Limited
Inco Ltd., Canada Copper Cliff, Ontario	Inco Ltd.
Japan	Lornex Mining Corp., Ltd.
Canadian Copper Refiners, Ltd.	Noranda Sales Corp. Ltd.
Canadian Copper Refiners, Ltd.	Noranda Sales Corp. Ltd.
Canadian Copper Refiners, Ltd.	Noranda Sales Corp. Ltd.
Canadian Copper Refiners, Ltd.	Noranda Sales Corp. Ltd.
Canadian Copper Refiners, Ltd.	Noranda Sales Corp. Ltd.
Canadian Copper Refiners, Ltd.	Noranda Sales Corp. Ltd.
Canadian Copper Refiners, Ltd.	Noranda Sales Corp. Ltd.
Canadian Copper Refiners, Ltd.	Noranda Sales Corp. Ltd., Hudson Bay Mining & Smelting Co.
Canadian Copper Refiners, Ltd.	Noranda Sales Corp. Ltd.
Mitsui Mining And Smelting Co., Hibi Smelter, Japan Dowa Mining Co., Onahama, Japan	Mitsui Mining And Smelting Co., Hibi Smelter, Japan Dowa Mining Co., Onahama, Japan
Japan	Philipp Brothers

SECTION IV: WORLD COPPER RESERVES AND ALTERNATIVE SUPPLIERS

This section, at first, is devoted to a brief study of the world short- and long-run copper reserves concentrating on land-based minerals; the potential of seabed nodules hereby are taken into peripheral consideration only. The main purpose of this section, however, is to undertake a review, most likely the most thorough of this entire study, of present and planned investment activities in the main and also in future copper producing countries which are and will become the alternative suppliers. In this way it is possible to provide an insight, however limited, into the prospects of the world copper industry in the foreseeable future.

World Copper Reserves

In the outer crust of the continental shelves of the earth, there are 28,000,000,000,000 tons of copper.[12] While this presents the continental potential without going deeper into the planet, it does not take into account the amount in the ocean crust nor the seabed nodules on the ocean floors with a much higher mineral content than the probabilistic, cosmic[13] occurrence of copper in that outer continental crust.

It is the ore reserves which are of interest and their changes occurring with the change in price --and the real cost of recovery-- of the mineral. It is to these reserves that the attention is now directed.

These reserves are broken up into short-run and long-run reserves. The former comprises all economically recoverable

Table 9

World Copper Reserves (Metal Content) in Millions of Metric Tons and Percentage Distribution

Country	Short-run Reserves (1)	%	(2)	%	Long-run Reserves (3)	%
U.S.A.	101	18.36	81.6	20.00	371.90	24.85
Chile	107	19.45	81.6	20.00	199.58	13.33
U.S.S.R.	40	7.27	36.3	8.90	117.94	7.88
Canada	35	6.36	36.3	8.90	154.20	10.30
Zambia	37	6.73	27.2	6.67	90.72	6.06
Zaire	26	4.73	18.1	4.44	45.36	3.03
Peru	35	6.36	27.2	6.67	63.5	4.24
Poland	14	2.55				
Philippines	20	3.64				
Australia	9	1.64				
South Africa	5	0.91				
China	5	0.91				
Papua N.G.	16	2.91				
Yugoslavia	100	18.18				
Others						
	550	100.00				
Other America			18.1	4.44	45.36	3.03
Other S. America			9.1	2.22	72.58	4.85
Other Europe			18.1	4.44	54.43	3.64
Other Africa			9.1	2.22	27.22	1.82
Oceania			18.1	4.44	72.58	4.85
Asia			27.2	6.66	181.44	12.12
			408.0	100.00	1,496.81	100.00
Sea-bed nodules					362.88	24.24

Source: (1) Duncan R. Derry, A Concise World Atlas of Geology and Mineral Deposits, Mining Journal Books (London, 1980), p.95. (2) and (3) H.J. Schroeder, loc. cit. n. 11, p. 298, Table 3.

copper materials to exist in known specific locations. With the change of copper prices these reserves tend to change. This is exemplified by the reserves in Table 9 column (1) and (2). Column (2) gives such a total for 1974/75 amounting to 408,000,000 metric tons. The reserve estimates of column (1) pertains, however, to the year 1979. A substantial increase of almost 35 percent is noticeable.[14,15] It means that by 1979 there were 550 million tons of copper available for exploitation.

The long-run reserves consist of the short-run reserves plus those mineral deposits which are known but are not yet economically feasible for extraction and those which still remain undiscovered. That total stands at about 1.5 billion metric tons.

The largest reserve holder in the long-run is the United States with almost 25 percent of the land-based reserves. In the short-run, it is Chile which appears to have larger known reserves in the short-run than it can claim in the long-run. It is in a strong second position with 13.33 percent.

The U.S.S.R. places third (7.27%) and fourth (7.88%) in short and long-runs respectively. For Canada, the positions are reversed as this country is counted to hold 6.36 percent in the short-run just like Peru and 10.30 percent in the long-run which puts it into fifth and third place.

Zambia is in fourth (6.73%) and fifth (6.06%) position followed by Peru, while Zaire is in seventh place (4.73% and 3.03% respectively).

In total these seven countries hold about 69 percent of both the short-run and the long-run copper reserves.

Naturally, there are other countries whose importance, though secondary in view of Table 9, may alter drastically as they may register larger deposits, unspecified in the Table. There is, e.g., China; its known deposits alone account for 50 million metric tons[16] which may have been included under Asia's (3) 181.44 million tons. Or take Poland: an ore potential of 1.5 billion metric tons at a grade of between 1.7 and 2.3 percent would hold approximately 30 million metric tons of copper. This total may have been included under other Europe (3), with a share of 3.64%. Another case in point is Australia. Its long-run potential, as much as that of Papua New Guinea, is, beyond doubt, quite substantial. However, these reserves are contained in Oceania (3) with 4.85% of the world share. Other countries in south America, such as Ecuador, Colombia, Brazil and Argentina are outstanding candidates as possible copper holders. The 72.5 million metric tons represent a reasonable if not conservative estimate.

To both these totals will have to be added the potential resources resting (and growing) on the bottom of the oceans. A long-run figure has been provided by Schroeder which, for all intents and purposes, is to be considered tentative. From the short-run point of view, however, it would be reasonable to add 30 million tons to the land-based reserves. This quantity follows logically from the analysis of the seabed nodule problem

discussed in Chapter VII on nickel. Given a short-run seabed nickel reserve estimate of 34 million metric tons, at a grade of 1.36 percent, nickel, (dry nodules), a copper content of 1.1 percent would be equivalent to those 30 million metric tons.[17] This tonnage raises the short-run total by about 5.5 percent over the 550 million metric tons of land-based copper reserves.

The long-run total of 1.5 billion metric tons would be raised by 24.2 percent were Schroeder's quoted tentative total of seabed nodule copper reserves of 363 million tons to be added. Since the opinions vary widely in this respect[18] there is no purpose in trying to discuss this point further. Truly Schroeder's assessment expresses one possible and valid opinion concerning the long-run reserves which is only remotely related to the time horizon of 25 years into the future as the main reference of this study.[19] Opinions differ on this point.

Alternative Suppliers

The following exposition will deal with the main alternative suppliers of copper in the world market which may affect the Canadian copper industry in terms of trade, employment and investment returns. This subsection is organized in the following way.

At first, North and Central America will be analyzed which is followed by a scrutiny of the regions of South America, Western Europe, Eastern Europe including the U.S.S.R., Africa, the Middle East, Central and East Asia and, finally, Australasia.

Thirty-five countries are involved and their investments in copper shall be reviewed and discussed as closely as possible. The basic structure is presented in Tables 10-19 spelling out the various investment activities.[20] The discussion will elaborate and comment on the given tabulated data to bring out more details than these tables can convey.

United States Copper Mine Production 1950: 824,900 metric tons

1979: 1,441,000 metric tons

Refined Copper Consumption 1950: 1,244,200 metric tons

1979: 2,221,190 metric tons

Copper ore production in the U.S. increased from 1,357.3 thousand metric tons in 1978 to 1,441.0 thousand metric tons in 1979, which means a 6.2 percent increase. This output was produced by a number of mines reflecting the industrial concentration of the copper mining industry: Four mines produced 45% while five mines accounted for 58% of output and an additional twenty mines produced a further 39 percent. This means that 25 mines in the United States mine 97 percent of the U.S. copper.

The mines in the State of Arizona produced about 65 percent of that copper ore, while the mines in Utah extracted 13 percent and New Mexico 12 percent, followed by Montana with five percent and Michigan with three; or in other words: five states supply 98 percent of the copper ore mined in the United States.

The distribution of smelters and refineries is as follows: There were 17 primary smelters operated by mining companies while 22 refineries and electro-winning plants were working for 17 companies.

The output of refined copper in the United States consists of primary and secondary copper. The following breakdown provides a view of the development of the production of refined copper in the U.S.A. during the period from 1975 to 1979:

Year	Secondary Copper Production as % of Total	Total Production of Copper ('000 metric tons)
1975	19.3	1,622
1976	19.5	1,736
1977	20.5	1,707
1978	22.5	1,869
1979	23.5	2,040

This small table explains two things: first, that the production of refined copper is rising in the United States and second, that in recent years, the quantity and shares of secondary copper used in the United States to produce refined copper have been on the rise.

The United States had to rely to a considerable degree on the import of copper amounting, on the average over those years, to about 380,000 metric tons. The main suppliers were Canada with 25 percent, Chile with 24 percent, Zambia with 15 percent and Peru with 12 percent. The remaining 24 percent of copper imports into the United States came from other copper exporting countries.

The following investment activities are noticeable for copper producing firms in the United States. After spending already $200 million on pollution control devices at Phelps Dodge's two smelters at Morenci and Ajo, by the year 1985, this company will have invested another $150 million on the operations at Morenci and $45 million at Ajo. The company contemplates tighter hoods and the application of oxygen-enriched air to reduce furnace emissions instead of rebuilding the two smelters.[21]

Anaconda stunned the mining world by the announcement of the agreement which the company reached with Japan for smelting about 353,000 metric tons of concentrate annually for seven years in Japan. This decision followed the closure of the company's Montana smelter due to the cost of compliance with EPA clean air regulations. Anaconda has also a copper-molybdenum property in Montana near Butte. It intends to build a plant which will be an extension of the existing Weed concentrator and is designed to process 43,500 metric tons per day. The cost will be $6 - 8 million and it should be in operation by July 1981.

Anaconda also had an underground mine and concentrator project under construction in Tooele, Utah, which was to start operations in 1979. Planned capacity was 12.7 thousand metric tons per day and the investment amounted to $135 million.

Asarco has been involved in mainly three copper projects:
1. In a joint venture with Anamax in the Eisenhower Mining

Company, Asarco had an open pit mine and a concentrator under construction at Palo Verde, Arizona, which was supposed to be on stream already in 1979. The expected capacity was 24.5 thousand metric tons of concentrate per year at an undisclosed cost according to the sources consulted. The same partnership was also involved in a mine expansion in Arizona to produce 11,000 metric tons of ore per day which was to be expanded to 13,600 metric tons per day later. 2. Asarco has also been engaged in a feasibility study involving an underground mine and concentrator project in Troy Montana. The planned capacity will amount to 7.7 thousand metric tons per day with an investment cost in the neighbourhood of $70 million. 3. Finally, Asarco is investing $70 million in the sinking of two shafts at Casa Grande, Arizona at a cost of $70 million to produce 6,350 metric tons of ore per day. This mine should be in operation in 1984.

Quintana Minerals Corporation and Phibro Mineral Enterprises have an underground mine and concentrator project under construction at Hillsboro, in Sierra County, New Mexico. With an expected lifespan of 15 years, this copper-molybdenum property under the company of the Copper Flat Partnership will produce 40,000 tons of copper per annum. The investment cost is $98 million and it should be in operation in 1982.[22]

Cities Services Minerals Group is reopening the Miami East underground mine in Pinto Valley of Arizona with a planned

capacity to produce 13,600 metric tons of copper. The investment includes a solvent extraction electro-winning plant at Pinto Valley, Arizona. The total investment amounts to $40 million and one of the main objectives is the utilization of at first 70 acres of mine waste dumps to extract additional copper through leaching operations. This is to start in 1982, and, according to more recent information, it is on time.[23]

Another important copper producer is Kennecott Copper. Two major investment projects are in progress: the first will cost $270 million and involves the building of a new concentrator and the expansion of the Santa Rita open-pit mine in Hurley, New Mexico. The capacity is to be 33,500 of metric tons of ore per day and it should be on stream in 1983. The second has to do with a new joint venture. Kennecott and Mitsubishi have entered into an agreement to own, operate and expand Kennecott's Chino Mine in New Mexico. Mitsubishi bought itself into the project with $116 million and will contribute an additional $133 million of the $400 to raise the annual output to 99,800 metric tons per year over the previous 59 000 metric tons. This means a 69 percent increase over the original capacity. The reserves are 362.9 million metric tons of 0.75% copper ores and Mitsubishi will receive one third of the output.[24]

Finally, Kennecott is making plans for building a plant to reprocess 2,000 acres of mining tailings to extract additional copper from the waste. The plant is to be located

at McGill, Nevada close to the Humboldt National Forest. It will cost $15 million to construct. The date of the start of operations is not yet certain.

Another joint venture is the Casa Grande Copper Corporation. It was formed between Hanna Mining and Getty Oil could see the operation of an underground mine at Prescott, Arizona. The ore reserve is 350 million tons or 317.5 million metric tons with a grade of 1% copper. Costs and start of the project are not certain.

The company of Oracle Ridge Mining Partners of Oracle Ridge in Arizona has an underground mine and concentrator project on the drawing board. It was to be on stream in 1980 as a joint venture between Continental Materials (55%) and Union Minière (45%). The planned capacity was 41,700 metric tons of concentrate of copper per year with an estimated ore reserve of about ten million metric tons.[25]

In short, the value of copper investments is no less than $1.285 billion in the United States alone, not counting the projects for which no figures were available. The net increase in output could be 250,000 metric tons of copper, roughly! These are more or less the beginnings of the overall expansion of the United States copper industry which is expected, according to a recent study by the U.S.B.M., to double its output by the year 2,000.[26] By then, the output, on the base of 1979 U.S.A. copper production, would be over 2.8 million metric tons of copper.

Mexico

Mine Production	1950: 61,700	
	1979: 104,400	69.2%
Refined Copper Consumption:	1950: 9,788	
	1979: 98,794	909.3%

Mexico is planning five major investments to expand the copper industry. The most important of these is a smelter and refinery project by Mexicana de Cobre which runs the La Cardidad mine with an ore potential of 670 million metric tons. Depending on the ore grade this mine has a considerable life expectancy which would extent at least until the year 2020 assuming just an average grade of one percent copper. The expenditure which has been set out in Table 10 would amount to $210 million. Of great significance is the addition to the refinery capacity which is planned to amount to 180,000 metric tons of copper. This means that, in reference to Table 7, Mexico would more than triple its refinery potential from 71.7 metric tons to 251,700 metric tons of refined copper. At the same time, Mexico would regain a substantial portion of the smelting capacity it has lost since 1955. It is therefore clear that Mexico, which consumed about 99,000 metric tons of copper in 1979 will appear as a very strong competitor in the world copper market considering that the copper mining output alone was 104,400 metric tons. It is, therefore, quite possible that Mexico, by the end of the decade will approach a copper production capacity of much above 300,000 metric tons. The following planned mining investments may lead the way into this direction. Industriales Pénoles, in a 40% partner-

Table 10
Copper Investment Activities in Mexico and Panama

Company	Location	Type of Proj.	Planned (Capacity) '000 metric tons	Actual (Capacity) '000 metric tons	What	Investment $ millions	Start	Comments
Mexico								
Cobre de Sonora	Santa Rosa/ Pilare.	open-pit & concent.	33.6/ year	-	con - centr.	130	proposal stage	Ore reserve is estimated at 130 million metric tons(0.83%Cu;also Mo and Ag).
Cia.Minera de Cananea	Cananea, Sonora	" "	140/ year	80/ year	"	50	1982	This is the second stage of the planned expansion.
" "	"	open pit	70/ day	30/ day	ore	250	1982	First stage of an expansion program.
Industrias Peñoles	Los Verdes	open pit& concent.	20/ year		con-centr.	26	1982	Cominco is a 40% partner.
Mexicana de Cobre	Empalme, Sonora	smelter& refinery	180/ year		copper	210		This is a 136 ooo metric ton /year refinery
Panama								
Empresa de Cobre Cerro Colorado	Cerro Colorado	total complex	24500/ year		ore	1 000	1980s	Rio Tinto has 49% interest in the project.
Cobre Panama	Petaquilla, Botija	open pit & con-centr.	5715 / year		ore	185	1987 if ?	This has been a feasibility study for a joint venture of Mitsui(50%), Dowa(30%) and Mitsuibishi(20%)

ship with Cominco at Los Verdes and the Cananea Corporation at Cananea will spend $26 million and $250 million respectively on the mining and concentrating of copper ores. The Cananea will spend an additional $50 million as the second stage of the overall expansion program. Here, the capacity of the concentrator will be enlarged. And, finally, there is the $130 million investment of Cobre de Sonora. It proposes to start an open-pit mine and a concentrator at Sanda Rosa. This project will deliver 33,600 metric tons of copper concentrate per annum. It is therefore, clear that Mexico with a possible investment plan of $846 million in the copper industry alone will become a substantial competitor in the world markets in the years ahead.

Panama

Another country to emerge as a very important supplier of copper is panama with definite plans to produce 24.5 million (if not over 30 million) tons of copper ore per year by the mid-1980s. This is of special significance since Panama is a complete newcomer on the world copper scene because it has been listed neither as a producer of copper nor as a consumer of the refined metal. Therefore, Panama will be a new entrant to the copper industry. Should the project of the Japanese consortium materialize, then, the competitive potention of Panama would substantially increase as it would provide substantial feed for Japanese

copper consumption. The total investment plan would cost $1.185 billion to deliver 30.215 million metric tons of copper ore per year.

Argentina

Mine Production 1950:
1979:

Refined Copper Consumption 1950: 1,651 metric tons
1979: 30,028 metric tons

After a turbulent history when Peron took over as President to the abrupt removal from office of his second wife when General Videla staged a successful coup, Argentina has tried to enter upon a new course, expecially in the economic field. The inflation rate which has been running at 400 percent in 1977, was reduced to 170 percent in 1979. This still places Argentina among the countries with the highest rate of inflation in the world; and if this country survived economically at all it was due to its agricultural strength. Unfortunately, the agricultural heritage was paired with an innate distrust towards industrialization and that is one reason why the mining industry has contributed but little towards the economy of that country. This is in spite of the fact of the immense mineral potential imbedded in Argentina's soil.

An important change in policy took place in November 1976 as an important incentive was created for the mining industry. The Law of Promotion of Mining was inacted which

Table 11
Copper Investment Activities in Argentina, Brazil and Colombia

Company	Location	Type of Proj.	Planned (Capacity) '000 metric tons	Actual '000 metric tons	What	Investment $ millions	Start	Comments
Argentina								
Cia Minera Aguilar	El Pachon	open-pit & smelter	100/ year		copper	1200	1986	800 million metric tons (St. Joe Minerals is involved)
Brazil								
Caraibas Metais	Camacari Bahia	refinery	150/ year		copper	430	1982	Technology provided by Outokumpu, Bipromet, and Asarco.
CVRD	Carajas, Para	complex	160/ year		copper	1500		Part of a 10-year $ 30 billion investment program which includes bauxite, manganese & nickel.
Cia. Brasiliera do Cobre	Camaqua	Undergr. & open pit mine & concentr.	1,270 / year	272/ year	ore	70	1980	Expansion of underground operations, New open-pit mine.
Serras do Leste	Chapada, Goias	open-pit mine	30/ day		ore	300		Parsons-Eluma has the contract; infrastructure required.
Colombia								
Government	Antioquia	mine				1000		Feasibility work for major development of the Pantanos-Pegadorcito ore-bodies

contained sweeping tax concessions which no mining country can afford to overlook.

Francis S. O'Kelly from the Mineral Consulting Services in Santiago, Chile, writes:

> «The most interesting feature of the new Law No. 20551 are generous income tax deductions for virtually all pre-production expenses. Income tax on dividends and capital gains tax is waived if the investment is made for a period greater than five years. Mines will enjoy a scaled reduction in VAT ranging over 15 years, starting from 100% in the first year and diminishing to a 10% relief in the last year of the tax holiday. The assessed value of the mineral reserve may be capitalised up to 50% thereby providing an element of depreciation. Finally, at the discretion of the regulatory authority, corporate taxation may be reduced or deferred as a special incentive.»[27]

This policy change marking a generosity towards the mining industry meant extraordinary incentives for the industry in Argentina.

On the top of the mining investment program is the exploitation of El Pachon deposit which was discovered early in the 1960s by St. Joe Minerals Company. A huge expansion project of St. Joe's operating Company, Minera Anguilar, is in progress involving $1,200 million (Table 11) O'Kelly places these investments even at $1,300 million[28] but, apparently, St. Joe Minerals Corporation, which is the general operator of the project, has withdrawn as the main financial supplier and backbone of that expansion. Considering that Argentian consumed the above-stated amount of 30,000 metric tons of copper in 1979, it would mean that an output of 100,000 metric tons by 1985/86 will be more than sufficient

to supply the domestic copper needs of this country.

Yet, this is not all. Argentina is pushing the mining industry forcefully ahead. There is a special Department for Promotion of Mining in the Mining Secretariat. It has opened a large mining registry to attract international investment for huge projects with the objective to change Argentina into a net minerals exporter.[29]

In order to put these plans into effect, Argentina tenders its largest known deposits of copper and precious metals, starting in 1981 with

(a) the Bajo de la Alumbrera deposit in Catamarca Province (copper and gold, 300 million metric tons of ore, (0.28 - 0.55% Cu));

(b) the Famatina deposit (copper and molybdenum, (0.1 - 0.5% Cu)in La Rioja Province); and

(c) the smaller Farallon Negro ore bodies in Catamarca Province (gold, silver and manganese).

Another six properties are under consideration to be opened up for international bidding in the year 1981.[30,31]

Given this tremendous change in mineral policy, the incentives will not fail to change Argentina into an alternative supplier of copper very soon, even if its geological conditions are less favourable than those of its western neighbour Chile, which enjoys higher ore grades on the Pacific side of the Andean Mountains.

Brazil

Copper Mine Production 1950:
1979:

Refined Copper Consumption 1950: 21,220 metric tons
1979: 225,000 metric tons

Brazil finds itself in a severe dilemma, especially in regard to copper. In the year 1979 it had to import more than 180,000 metric tons of copper, not to mention scrap, finished or semi-finished copper materials. The problem in Brazil is (a) that promises to change the mineral policy did not materialize, (b) that the private sector did not display the interest in mining it was expected to and that thus transfers of property moved ore deposits from one government company to another, (c) investment returns in other areas such as real estate were better than in mining, and (d) that with the exception of the U/S/ Steel Corporation which became involved with the mammoth project at Carajas - gold, copper and manganese - multinational companies did not find themselves attracted to enter areas generally dominated by Brazilian firms.[32]

Brazil has placed its hopes on a new 10-year mining plan with the aim to provide incentive to private Brazilian enterprises. The incentives included deduction on income taxes, exploration and development costs and rewards to mining companies of 51 percent and more Brazilian ownership.[33]

Until positive results are in, Brazil will have to rely on the Caraibas Metais (Table 11) and the Eluma projects;[34]

the latter is to produce 100,000 metric tons of copper while the former is expected to deliver 150,000 metric tons to supply Brazil's domestic copper needs. If the 10-year Carajas project is successful, Brazil can be expected to produce 410,000 metric tons of copper. Let us assume at this point that, then, Brazil, would be self-sufficient. This would mean that its imports which stood at 180,000 metric tons in 1979, will be completely substituted by domestic production and a corresponding amount would not be imported by 1990. In turn, the initial foreign suppliers of copper will have to search new customers and markets; international competition will tend to be respectively stronger! Brazil may even become a copper exporter!

Colombia

Mine Production: insignificant

Refined Copper Consumption 1950: 544 metric tons
1977: 16,511 metric tons

A small copper mine at Payande - the Mina Vieja in the Department of Tolima - marks the actual copper mining capacity of Colombia at the end of the 1970s. This mine still produces about 100 metric tons of ore per day with a grade of 2 percent copper.[35] Naturally, this is an astonishingly small quantity for a country whose geology is very similar to mineral surroundings of its Andean neighbours. Understandably, many parts of this country are difficult

to access, but the main reason is that relatively little geological survey work and prospecting has been undertaken in the past. Fortunately, there are important signs now that things will change as the government of Colombia is interested in the opening-up of the back country for resource exploitation. This is done with the aid of technological know-how and the finances of multinational corporations such as Exxon.

What is true for the potential of the development of nickel properties in Colombia is likewise true for copper. There are huge deposits known to exist such that the start of a mine is under serious discussion in the Department of Antioquia (Table 11). The ore deposit in question extends over an area of 30 square kilometers. However, by the end of the year 1980 still another 3.8 kilometers of drilling had to be carried out before the second stage, including metalurgical work, could be undertaken.[36] There is no doubt that this could be a very important mineral project in Colombia. Furthermore, the State Agency of Ecominas is considering similar exploration work for the copper reserves of the Southern Putumayo jungles and in the southern part of Narino. These are aspects which in no uncertain terms underscore the extensive copper potential of Colombia.

In addition, the word is that a 600 million metric ton copper-molybdenum deposit has been discovered at Mocoa,

which is located between the western and eastern Andean Mountain Ridges close to the border of Ecuador.[37] In all, the general mineral and,especially,the copper potential of Colombia is great and, though not yet satisfactorily quantified, it may bear witness to the competitive strength luring at a relatively close horizon for the world copper industry.

Chile

Copper Mine Production 1950: 362,900
1979: 1,064,680

Refined Copper Consumption 1950: 19,360
1979: 48,535

Chile has become a symbol of copper production in the world and the planned investment activities, as set out in Table 12, testify that this country will continue to live up to expectations emanating from this its, mineral stature.

According to the mentioned Table the total investments earmarked for the copper sector of the Chilean economy amounts to $6.111 million, which will have to be adjusted later. The stated amount however, is smaller than the total in Table 12 due to the termination of the agreement on the development of the Andacollo property between Noranda Mines of Canada and the Chilean Government at the end of 1980.[39]

However, for the Chilean picture to be more complete two new mining projects would have to be included. For the year 1981 two new mines are supposed to be on stream in the

Table 12
Copper Investment Activities in Chile

Company	Location	Type of Proj.	Planned (Capacity) '000 metric tons	Actual '000 metric tons	What	Investment $ millions	Start	Comments
Chile								
Anaconda	Los Pelambres	complex	27-63.5/ day		ore	1500	1986	$ 6-8 million are being spent for delineating the the deposits until the end of 1982.
Codelco/Noranda	Andacollo	open-pit mine& concentr.	40/ day		ore	380	1983	Financing is not yet settled.
Codelco	Andina	under-ground mine	20/ day	14/ day	ore			Is being studied.
Codelco	Chuquicamata	open-pit mine& concentr.	87/ day	63.5/ day	ore	119	1982	This implies adding grinding and float-ation capacity.
Colelco	El Teniente	complex	342/ year	261/ year	copper	1500	1985-1990	Ten-year,stage exp. program.
Codelco	El Salvador	under-ground mine and concentr.	28/ day	22/ day	ore	47	1-82	In progress.
Exploration Dona Ines	Quebrada Blanca	open-pit mine& smelter& refinery	100/ year		copper	500	1985	Consortium:govern't, Superior Oil, McIntyre Mines,and Falconbridge.Pre-feasib'y:Brown & Root.

Table 12(continued)
Copper Investment Activities in Chile

Company	Location	Type of Proj.	Planned (capacity) '000 metric tons	Actual '000 metric tons	What	Investment $ millions	Start	Comments
Exxon (Disputada)	Los Broncos	open-pit mine	80/ day		ore	2000	1986	Under feasibility study.
Minera Pudahuel	Charnal	complex	20.8/ year		copper	60	1983	This mine will feed leach-solvent, electro-winning plt.
Minera Pudahuel	Iquiqui	mine	3.6/ day	2.5/ day	ore	5		Sagasca operations revived.

year 1981. They are:

(a) The El Indio Mine, at Santiago and owned by the Campania Minera El Indio with an annual capacity to produce 12, metric tons of copper, and

(b) the Le Aquirre Deposit of the Pudahuel Sociedad Minera Ltda which would produce 20,000 metric tons per year[40] in one unit with 16,500 metric tons in another.[41] The additional investment amounts to $100 million.

Finally, certain other adjustments will have to be made to appraise more completely the full investment activities in the Chilean copper industry. Recently, further government intentions were made public which affect the more immediate Chilean copper prospects.

(Million of $U.S.)

	As per Table 12	Government policy[42]	Difference
Chuquicama	119	877	745
El Teniente	1,500	734	(ten-year project = unaffected)
El Salvador	47	130	83
Andina	not given	99	99

When this difference of 927 million is added to the net sum 927 of Table 12 it would appear that approximately $6.76 billion will be channelled into the Chilean copper industry during the 1980s, as may be seen at this point in time. As Table 12 also suggests, the present outlook into the foreseeable future would raise the quantity of processed by 200,000 metric tons bringing the Chilean refinery capacity - following Table 7 - closer to the one million metric ton mark.

Naturally, Chile will encounter certain difficulties in maintaining copper production as the copper grade is expected to decrease from the current average of 1.78 percent to 1 percent at the end of the century.[43] Accordingly, Codelco's output will peak with 1,005,000 metric tons per year between 1986 and 1990 after which it would decline to 767,000 by the end of the century.

It is, then, the private sector which will come to the fore to prop up Chilean copper production and expand it further. Several private firms have committed themselves to massive investments in copper. They are of Chilean as well as international character. Even if the Noranda-Chile agreement is defunct, Anaconda, Superior Oil McIntyre Mines Falconbridge and Exxon, no doubt, will make spectacular contributions to push ahead towards the official Chilean target to produce 2,000,000 metric tons of copper per year by the year 2000.[44]

It is also of interest to note that the Exxon Mineral Corporation alone will invest $2 billion in Chile to produce copper there, while the same company, after reorganization and consolidation of all foreign and United States mining operations, decided in February of 1981 against the continuation of the Pinos Altos project in New Mexico.[45]

This only goes to show that large corporations channel money into overseas ventures when such action would appear economically feasible or of attractive profitability. A

recent report by T.T. Tominatsu of the U.S.B.M. recognized this fact when he wrote that «the higher-grade (and hence lower cost) deposits overseas are profitable enough to offset any potential risks of overseas operations.»[46]

In short, Chile, perhaps presently the freest market economy in the world, and the multinational corporations will work towards the doubling of Chile's copper output by the year 2000, and during this decade they will pump in $6.76 billion to accomplish this objective.[47]

Peru

Mine Production 1950: 30,300 metric tons
1979: 379,900 metric tons

Refined Copper Consumption 1950: (Normally incl. in «Other America»)
1979: 21,300 metric tons

Peru is, what might be called a military government in transition towards democarcy. The civil administration under the military rule, after some difficult times of strikes and stern economic measures falling chiefly upon the country's poor and its middle class, has put the economy on a sound basis. Enjoying a continuous export surplus, Peru's international reserves went into the black in 1977. Two years later Peru had managed to add a surplus of $460 millions to its credit.[49]

In Peru, about 90 percent of all copper is mined by the following three corporations: 1. Southern Peru Copper Corporation (SPCC). 2. Minero Peru (Cerro Verde). 3. CENTROMIN.

Table 13
Copper Investment Activites in Peru

Company	Location	Type of Proj.	Planned (Capacity) '000 metric	Actual '000 tons	What	Investment $ millions	Start	Comments
Peru								
Centromin Peru	Cobriza	Under ground mine & concentr.	9/day	2.4/day	ore	181.3	1982	
Centromin Peru	La Oroya	smelter& refinery	73/year	58/year	copper	140.7	1982	
Centromin Peru	Toromocho	complex	83/year		copper	750		In initial proposal stage.
San Ignacio de Morocha	San Vincente	mine	2/day	1.5/ day	ore	9		Also a new hydro-electric plant.
Minero Peru	Cerro Verde	open-pit mine& concentr.	75/year	33/year	copper	252	1984	More financing req. before constr.begins.
Minero Peru	Cerro Verde	open-pit mine	20/day		ore	250	1983	2nd stage of development for Cerro Verde.
Minero Peru	Ilo	refinery	300/ year	150/ year	copper	120		Expansion is financed by Mitsui,Furukawa ,and Maerz from Switzerland.
Minero Peru	Quellaveco	open-pit mine& concentr.	20/day		con-centrate	300		Ore reserve: 385 million metric tons;grade0.85% Cu, financing req.before construction can begin.
Minero Peru	Tintaya	" " "	8/day		ore	208		Ore reserve:51 million metric tons,2% Cu. Financing req.before constr. can begin.

In the year 1978 the Aguila Mine located 250 km north of Lima went into operation to produce 60,000 tons of concentrate containing 25% copper. A new flash smelter of a new company - Fundicion del Norte, S.A. - will treat the copper of the Aguila mine and of other mines. This smelter has a capacity of 37,000 metric tons of processed copper.[50]

Furthermore, CENTROMIN has a smelter and refinery under construction which will increase its capacity in La Oroya (Table 13) by 15,000 metric tons to 73,000 metric tons per annum. Also, a mining-refining complex at Toromocho is being considered to add 83,000 metric tons of copper to its capacity, although financing has not been finalized. Total expenditure plans by CENTROMIN should amount to an investment of 1.07 billion if the underground concentrator at Cobriza is added. This last project should be in operation by 1982 at a cost of $181.2 million. When taking a longer view, one can perceive that the three stages of the Toromocho project will run up to an expenditure of $1.5 billion.

Minero Peru has even larger investment plans on the drawing boards. Its total amounts to $1.68 billion although some of the development programs are in the planning stages only. In Cerro Verde, an addition to the copper capacity of 42,000 metric tons is planned to see production go to 75,000 metric tons. This is to be on stream in 1984 at a cost of $252 million. By 1983, an open-pit mine is to deliver 20,000 metric tons of copper in ore-form with an

investment cost of $250 million. Minero Peru will also increase its refinery capacity at Ilo from 150,000 to 300,000 metric tons at a cost of $120 million. This project is being financed by a Japanese-Swiss consortium composed of the corporation of Mitsui, Furukawa and Maerz.

At Quellaveco and Tintaya, $300 million and $208 million are earmarked to operate an open-pit mine and concentrators with respective ore reserves of 385 million metric tons (0.85% copper) and 51 million metric tons (2% copper). In addition, 25 kilometres north of Chimbote a $15 million smelter with a capacity to produce 150,000 metric tons was to be started.[52]

In short the processing capacity of Peru will see an increase by almost 300,000 metric tons in the early 1980s. When adding the Chimbote smelter and the San Vincente mine project the total investment in the Peruvian copper mining industry would stand at $2.836, while the copper output itself would rise by 75 percent to 700,000 metric tons. Finally, if one bears in mind that the international financial position of Peru has changed for the better, the entire economic and market position of Peru is also very positively affected. This is not to say that Chile's miraculous example is spreading to other areas although such a possibility cannot and should not be entirely excluded. Yet, the recent following policy changes made possible through the improvement in the balance of payments situation seem also to follow

the neighbourly, Friedmanesque prescriptions.

At first, the Peruvian government has surrendered its monopoly on refining and the marketing of minerals; then, it has modified the restrictions on private foreign and local large-scale mining in Peru; in addition, it has cancelled a burdensome 17.5 percent mineral and petroleum export tax and has replaced it through a general export and sales tax which is to be reduced to 5 percent within two years. Furthermore, local and foreign investors may form joint ventures with the state company Minero Peru which should retain not less than 25 percent ownership.

This reversal on a broad front of mineral policies set up by the military government of ten-years standing is expected to have considerable appeal domestically and should attract foreign companies to get, above all, the Tintaya project started.[53]

Copper Investment Activities in Western Europe

France

Copper Mine Production 1950: 900 metric tons
1979: 400 metric tons
Refined Copper Consumption 1950: 115,214 metric tons
1979: 348,093 metric tons

Considering the huge amount of copper needed to feed the French industrial complex and the insignificant quantities of mined copper, it does not take wonder to see France embark upon consecutive five-year prospecting programs. The first of these to establish the French domestic mineral potential was completed in 1979 followed immediately by the second program.

Valuable discoveries have been made which included three important copper potentials:

1. In Brittany, and orebody was discovered with 2.6 million metric tons of ore with the following mineral content: 1.65% copper, 4.3% zinc, 2.65% lead, and 83 grams of silver per metric ton.
2. In the Loire Valley, the Bodennec deposits (Finisterre) with 7 million metric tons of ore and a metal content of 3% (see also Table 14), and
3. The Portes aux Moines deposit (Côtes du Nord) with 2.5 million metric tons of ore and a combined grade of 12% of lead, zinc, copper and silver.

Table 14
Copper Investment Activities in Western Europe

Company	Location	Type of Proj.	Planned (Capacity) '000 metric tons	Actual (Capacity) '000 metric tons	What	Investment $ millions	Start	Comments
France								
BRGM	Bodennac	underground mine & concentr.	18.1/ year		concentrate	600		Feasibility study under way in 1980.
Portugal								
Penarroya BRGM	Alentejo	mine& plant	50/ year		copper		1985/6	Massive sulphide deposits;further financing req.before construction start.
Spain								
Rio Tinto Minera	Rio Tinto	open-pit mine &concentr.	50/ year	20/ year	conc.		1980	Expansion project.
Sotiel Coronada	Sotiel,Huelva	mine	2/year		copper	115	1982	Includes a 490,000 metric tons peryear H_2SO_4 plant.
Sweden								
Boliden Metall	Gallivare	open-pit mine	11,500/ year	8,000/ year	ore	27.3		This is an expansion of the Aitik mine.
LKAB	Kiruna	underground mine &concentr.	50/year		conc.	50		Construction to begin in 1981.

Indications are that similar mineralizations will be found at three different locations:

a) at Menz Albot (Finisterre)

b) at Plélauff-Gouarec (Côtes du Nord) and

c) at Rouez (Sarthe) where a huge pyrite deposit has been discovered.

A research combine of SNEA and BRGM has made plans to open a mine.[54] Besides this general intention, BRGM, as indicated in Table 14, is undertaking a feasibility study in the Bodennec area to start mining operations to produce 18,100 metric tons of concentrate, needed for this project and there is no doubt that this undertaking means a serious beginning not necessarily to solve but, at least, to modify a very critical import problem for France.

Portugal

Copper Mine Production 1950: 180 metric tons
1979: 2100 metric tons

Refined Copper Consumption 1950: 608 metric tons
1979: 15966 metric tons

Portugal has been greatly dependent on imported and recycled copper since its mines produced but about 13 percent of its domestic consumption. This import dependence will change when mining operations begin in 1986 requiring an investment of $600 million.

The Castro Verde deposit (Table 14) discovered by Penarroya and BRGM will come under a new company which besides the two discovery firms, will have the state for a third partner.

The reserves, originally estimated at 50 million metric tons of ore, are much larger - and still 'growing'. About 30 percent of this exceptional deposit contains a copper ore with a grade of 5.77%(!) and 29 grams of silver per ton. The remainder of the orebody holds 1.05% copper, 0.8% of lead, 4.32% of zinc and 52 grams of silver per ton.

Eventually, when this mine is in operation it will reduce the copper import dependence of this European country. This means that the exporting countries will experience a relative decline in demand for their own copper later in the 1980s.

Spain	Copper Mine Production	1950: 6,500 metric tons
		(x 6.435)
		1979:41,830 metric tons
	Refined Copper Consumption	1950: 8,201 metric tons
		(x 15.97)
		1979:131,000 metric tons
		(Factor 2.754)

The above-stated production and consumption performances of Spain describe its basic copper problem. Refined copper consumption outstripped mine production by a factor of 2.75. A one percent increase in mine production had to live up to a consumption increase of 2.75 percent. In other terms: Spain's consumption of refined copper is 3.1 times larger than its domestic mine recovery. Officially, the net import debit amounted to 55,000 metric tons annually in the late 1970s. In short, over 50 percent of copper consumed in Spain comes

from abroad.

To remedy this serious situation, the Spanish government has introduced certain policy changes. There is above all Spain's Mining Development Law. It aims at reducing the Spanish copper import dependence from the recent 55% to 39% by 1982 and to 25% by 1987.[56] Spain is expecting that its copper mines will raise copper output to 84,000 and to 120,000 metric tons for 1982 and 1987 respectively.

Four projects are to serve this end. They are:

1. The exploitation of an immense pyritic mineral reserve with a very low (0.3%) copper grade. This deposit is to deliver 2.2 million metric tons annually. It is part of a $125 million sulphor, iron and copper project which is to supply 6,800 metric tons of copper annually, besides 4,000 metric tons of lead, 15 metric tons of silver and 0.3 of a metric ton of gold.

2. The second project is in the hands of Sociedad Andaluza de Piritas S.A. (ASPIRSA) which is to mine two orebodies at Aznalcollar: one consists of 43 million metric tons of pyrites (0.44% copper, 1.77% lead, 3.3% zinc, 67 grams of silver per ton and 1 gram of gold per ton); the other contains 47 million metric tons of pyroclast with 0.58% copper, 0.4 percent zinc and 10 grams of silver per ton. This will involve an open-pit mine to produce 6,250 and 10,750 metric tons of copper per year respectively.

3. The third project is listed in Table 14 and pertains to the second largest sulfide deposit at Sotiel (Huelva). This mine is to be developed by Minas de Almagreva S.A. and it can draw on an orebody of 40 million metric tons containing virtually the same grade of minerals as the Aznalcollar project. The expected output will be 2,120 metric tons per year of copper.

4. The fourth of the sulfide projects involves Rio Tinto Minera S.A.'s orebodies at San Dioniso and San Antonio with a reserve of 40 million metric tons of copper ore. At first 18 million metric tons are earmarked for extraction of 1 million metric tons per year with a grade of 1.7% copper. The cost will be $70 million and the annual output between 1980 and 1995 is scheduled at 14,220 metric tons.

Therefore, $545 million are allocated to these mining projects to produce a variety of metals. Especially, copper production alone will increase by 40,140 metric tons per year drawing on a reserve of 170 million metric tons of sulfides, not counting the pyrite ores.

Sweden Copper Mine Production 1950: 16,100 metric tons
1979: 50,430 metric tons
Refined Copper Consumption 1950: 48,898 metric tons
1979:109,045 metric tons

Sweden is another of those countries which consume more copper than they mine. Therefore, the attention which Sweden attaches to the development of copper mines is all the more understandable. Two projects appear to be in the forefront to raise Sweden's copper output. One is the expansion of the Boliden Gallivare deposit increasing the mining output of copper by 44% at a cost of $27.3 million (Table 14). In the same table, the second development project in the copper mining industry is indicated to be undertaken by the government corporation LKAB. More recent information will see the Viscaria A.B. company, a wholly owned subsidiary of LKAB ($11 million share capital), funnel $80 million as capital investments into the project including $8 million as working capital. This mine will exploit 1 million metric tons of ore per year.[57] The grade ranges between 1.9 and 2.5 percent copper of a deposit of 14.5 million metric tons. It has relatively easy access since it is located only 100 metres below the surface. Fortunately enough, this deposit is adjacent to the famous Kiruna iron ore deposits and lies at the Narvik railroad facilitating exports to continental customers via Narvik or, inland, to Sweden's Boliden enterprises for processing. Copper output from this mine alone would run between 13,000 to 25,000 metric tons of copper output per year.

Copper Investment Activities in Eastern Europe

Bulgaria Copper Mine Production 1979: 59,950 metric tons

Refined Copper Consumption 1979:57,879.4 metric tons

To judge by the above-stated production and consumption statistics it is clear that Bulgaria can easily cover its consumption needs for copper from its own mines. Yet, Bulgaria is speeding ahead with the construction of the largest ore-dressing combine in its non-ferrous metal industry: The Elatsité Combine.

At the same time, a new copper ore deposit at the Sredna Gora Mountains is being opened up which is the largest of its kind in Bulgaria and reportedly the 26th largest in the world.[58] The amount invested is $33 million (Table 15) with installations designed by experts from Bulgaria and the Soviet Union but supplied by the U.S.S.R. In short, Bulgaria's copper production in the foreseeable future will be greater than its domestic consumption will require such that it may well sell copper on the world market or within the market organization of the centrally planned economies.

Poland Copper Mine Production 1979: 319,900 metric tons

Refined Copper Consumption 1979: 185,159.5 metric tons

The total production of electrolytic copper in Poland rose to 335,800 metric tons in the year 1979.[60] In the same year Poland was also able to export 198,000 metric tons of

Table 15
Copper Investment Activities in Eastern Europe

Company	Location	Type of Proj.	Planned (Capacity) '000 metric tons	Actual (Capacity) '000 metric tons	What	Investment $ millions	Start	Comments
Bulgaria Government	Asarel	open-pit mine				33	1983	Using Sovjet equipment.
Poland Government	Glowgow II	refinery	430/ year	300/ year	copper		1980-1982	This is another expansion of the $ 1 billion Glowgow complex.
Government	Sieroszowice-Cedynia	mine						The fourth mine to feed the Glowgow No.2 refinery.
Yugoslavia Government		mine& refinery	8,000/ year 28/ year		ore copper		1981	

copper and copper semiproducts. These exports generate part of the necessary receipts which Poland can allocate towards the redemption of its international debts.

The mining output stems from the old Konrad mine and the new underground mines in the Legnica-Glogow Copper Regions (Table 15).

Poland started to make a strong bid to become one of the world's major copper producers as early as 1975. Poland's new source of copper, heralded as one of the largest single find, was discovered near Wroslaw of Southwestern Poland in the late 1950s. The development of these unbelievably rich deposits was undertaken with both Western technology and Western finance. Two consortia helped to pave the way: one, led by Chase-Manhattan, lent $240 million to Poland, and the other, consisting of three German banks,provided $125 million over a period of ten years with an annual return of 40,000 metric tons of wire bars and cathode copper; this mode of repayment was to last for a period of twelve years.[61]

In 1977, three mines existed in the Lubin-Polkovice-Rudna area with an ore-potential of 1.5 billion tons. When Poland began the expansion of its copper complex 18 years ago, production soared from 72,200 metric tons in 1970 to 248,000 metric tons in 1975. The general aim is an output total of 400,000 metric tons which will not be far from realization after the second oxygen-enriched flash-smelter

Glowgow II is in operation. Eventually, when the third stage of the project is completed - Glowgow III - total capacity may well be around the 550,000 metric tons mark annually.

Furthermore, plans have been drawn up to transform the whole area into an industrial complex which will be comparable to the German iron-and-steel based complex of the Ruhr. The final picture would see 5 million people living in the present cities of Lubin, Legnica and Polkovice.[62]

According to more recent information the Government of Poland intents to expand the Glowgow - $1 billion - complex from a 300,000 ton refinery capacity to 430,000 tons.[63] This follows the general trend of expansion and development of the region. It will assure Poland an ever-increasing share in world copper output. Even the labour turmoil in Poland does not seem to have affected the country's copper production. Poland has long-term contracts with foreign companies in Germany, Belgium, France, and Britain involving the annual exports of 100,000 metric tons, while 200,000 metric tons are for Poland's internal consumption.[64] Occasional spot sales in the world market have occurred although, normally, any surplus is understood as earmarked for exports to the U.S.S.R. and Eastern Germany.

General Annual Production Objectives;

	Smelter Capacity	
Glowgow I	270,000 metric tons	1976
Glowgow II	300,000 metric tons	1980
Glowgow III	550,000 metric tons	1990(?)

In addition: 100,000 metric tons continuous wire rod plant (1971) and an 80,000 metric tons plant for making copper sheet and strips, near Legnica.

The general ore quality is: 9.8 - 15 feet in thickness; 1.7% - 2.3% copper grade, 30 - 50 grams of silver per ton, and the ore is located 1960 - 2290 feet, down to 3600 feet, with the copper base sloped at 1° - 4°.[65]

Yugoslavia	Mine Production 1950:	43,300 metric tons
	1979:	119,180 metric tons
	Refined Copper Consumption 1950:	18,779 metric tons
	1979:	208,112 metric tons

The above statistics demonstrate the difficult position Yugoslavia finds itself in at the end of the 1970s after enjoying an early phlethora of domestically mined copper in face of a very small consumption demand for this metal. By 1979, consumption outstripped the mining output by 1.7:1.

Yugoslavia's two main mines at Bor and a Majdanpek in Serbia have been experiencing declining output; this holds likewise for the production of electrolytic copper which

was down to 137,506 in 1979 from 150,000 metric tons in 1978.

Yugoslavia's copper industry has to enlarge its operations to overcome the gap unless it wants to rely on imports of copper, a suggestion which is heresy in centrally-planned economies.

Several projects may serve the purpose of enlarging the copper potential of Yugoslavia. At first, there is a huge mining and concentrator project under construction in connection with the so-called Bucim copper deposit. The Davy McKee Corporation has been instrumental since 1969 to bring this project to fruition. Information on the Bucim deposit has become available as early as 1906, but proper exploration did only start in 1965. According to A.F. Westergard, senior project manager of Davy McKee Corporation, the proven ore deposits amount to 105 million metric tons,[66] and further exploration should increase the mineralization substantially. Karl Lavrenic assigns a total reserve of 1 billion metric tons of ore to the location.[67] So far, three ore deposits are included in the development program. They are: a) Cukar, with a reserve of 21 million metric tons and a grade of 0.7% copper; b) Vrsnik, with 21 million metric tons of ore and a copper grade of 0.5%; and c) Bucim, with an ore reserve of 73 million metric tons averaging only 0.38%. The Cukar deposit should be exhausted within three years as 3.72 million tons will be mined annually; then, the

Vrsnik deposits will be started in 1981 with the extraction of 5.4 million metric tons annually while, finally, the Bucim deposit is to be phased in by 1983 with an annual output of 7.2 million metric tons.[68] According to Westergard, «the Bucim operation uses conventional open-pit mining and ore processing methods and includes some of the largest mining and processing equipment in the world.»[69]

Besides 0.5 metric ton of gold and 2.5 metric tons of silver, the ore concentrate to be refined in the Bor complex will deliver 21,000 metric tons of refined copper per annum. The project of the Bucim plant is located at Radovis in southeastern Macedonia and the mine and its flotation plant will cost $85 million to construct. It is also important to realize that the ore grade is of a relatively rapidly decreasing quality.

The second major project will tap the new copper mine at Velikj Krivelj (Table 15). 28,000 metric tons of electrolytic copper will come from this endeavour as 8 million metric tons of copper are to be treated annually in a flotation plant which is under construction. The ore reserve is more than 700 million metric tons with a copper grade of 0.41 percent.

The third project lies still far away in the future and would involve the exploitation of 60 million metric tons of ore discovered in 1979 near Kratova in Macedonia. This reserve will prove very useful in supporting the Yugoslavian

copper industry at a time when the other ore deposits will show signs of depletion.

In all, 49,000 metric tons of refined copper will be added to the copper production capacity of Yugoslavia in the foreseeable future due to the Bucim operations and the Velikj Krivelj project.

U.S.S.R. Copper Mine Production 1950: 200,000 metric tons
1979:1,139,740 metric tons
Refined Copper Consumption 1950: 220,721.8 metric tons
1979: 1,329,864 metric tons

Smelters: 13

Refineries: 11

Concentrators 40 with milling capacity of 125 million metric tons of ore to produce 5 million tons of concentrate.

65 mines (underground or open-pit), with 80% of the ore coming from open-pit mines; 10% as by-products from poly-metallic mines.

By the year 1978 the U.S.S.R. had 13 copper smelters in operation with a daily capacity of 1.1 million metric tons. Its production of copper ore(metal content) had been estimated at 1,139.74 metric tons both in 1978 and 1979.[72] The following breakdown presents some critical features of Russian ore production and consumption as well as the imports into the U.S.S.R. of Canadian copper ores, concentrates or matte.

Metric tons

	Ore production	Refined copper Consumption		Imports from Canada
	(1)	(2)	(1):(2)	
1978	1,139.7	1,323.4	86.1	8.285
1979	1.139.7	1.323.4	86.1	20,773

By comparing ore production to consumption of refined copper, at least for the years 1978 and 1979, one realizes that the ore production amounts to 86 percent of final, industrial consumption. As a matter of fact, this ratio is somewhat larger than was established for the rest of the world (Table 2). The difference is made up from secondary copper in the forms of old and new scrap and from imports. In this area Canada has made its contribution, and this at an increasing rate in recent years as seen in Table A7. However, it is also clear that Russia is not copper import-dependent because it is a net exporter of the metal.

Copper Exports of the U.S.S.R. for the Years 1975 to 1979 e)

(Metric tons)

Year	Unwrought, unalloyed	Alloyed	Semi-manufactured Copper Unalloyed	Alloyed
1975	205,620	4,240	9,215	8,400
1976	220,000	7,000	9,000	9,000
1977	220,000	7,000	9,000	9,000
1978	240,000	7,000	9,000	9,000
1979	240,000	7,000	9,000	9,000
1980	250,000	(expected)		

Source:[73]

e) estimates as stated by Strishkov, for the years 1976 to 1979. In 1970 exports were 123,000 metric tons.

In essence, the U.S.S.R. is a net exporter of copper amounting to 265,000 metric tons for the year 1979.

The secondary supply of copper in the U.S.S.R. comes from blister copper production by the Kirovgrad smelter in the Ural Mountains, by the Moscow smelting and electrolytic plants and by a number of small plants in the secondary non-ferrous metal sector.

As regards ore production, the U.S.S.R. runs approximately 40 concentrators with an estimated capacity to produce copper concentrates of 5 million metric tons. The capacity use in recent years has been about 80 percent as 4 million metric tons of concentrate has been produced. The concentrate is of varying grades ranging from 12 to 36 percent with an average estimated at 20 percent.

The overall copper tonnage delivered was 125 million metric tons mined by 65 underground and open-pit mines, the latter counting 80 percent of total mining output.

When the 1975-1980 Five-Year Plan was announced, it was the intention to raise copper output in the U.S.S.R. by between 20 and 30 percent by 1980 over the 1975 output level. Considering that the U.S.S.R. produced 980,000 metric tons of blister copper including 95,000 metric tons of secondary copper, the Soviet plans are reported to aim at an output of 1 million metric tons of refined copper in 1980, and according to Strishkov - the main reference - «production is estimated at probable 1.15 million tonnes in 1985 and 1.3 million tonnes in 1990.»[74]

The Asian mining areas play an important part in the Russian copper industry. 80 percent of all copper comes from there. The 1976-1980 plan had provided for a 25 percent increase in output in refined copper in Kazakhstan alone. In addition, the Norilsk No. 2 copper and nickel smelter built with expert Finnish assistance, is to deliver 650,000 metric tons of copper concentrate, or 200,000 metric tons of copper (and 550,000 metric tons of nickel concentrates or 100,000 metric tons of nickel).

In view of the expansion programs in the copper industry some estimates have it that the U.S.S.R. copper output will rise by about 13 to 15 percent over any given five year period. This would mean that the Russian copper output would stand at almost 1.7 million metric tons by the year 2000. This is a hypothesis based on a growth rate of 14 percent over five years and its realization depends on so large a number of factors and events in the unforeseeable future that one cannot assert that this assumed target will be reached.

No doubt, it is of interest to restate that the copper reserves of the U.S.S.R. given a grade of 1.1 percent copper and a 3.600 million tons ore reserve, the metal content would be 40 million metric tons. This is the same reserve figure given under short run reserves for the U.S.S.R. by Duncan R. Derry in Table 9 above. The mineral sources are cupri-

ferous sandstones and porphyries. Strishkov also points out that there is an ore potential connected to the Udokan deposit of Eastern Siberia with 700 million metric tons (1.15 percent copper) which is to be developed jointly with the assistance of British, French and Japanese firms during the 1980s.

As most of the deposits and reserves are in areas remote from large population centres and from the highly industrialized parts of western Russia, development will encounter delays and difficulties.

Kazhastan accounts for 50 percent of copper production in the U.S.S.R. with the following four main areas: Dzhezkazgan, Kounrad, Boshekul and the Altay. They contain 48 known deposits with 19 holding 2/3 of this region's reserves.

The next biggest producer is the Ural. Its chief reserve consists of copper pyrites containing other metals such as zinc, gold and silver. The number of deposits known is about 100. The third most important copper area is Uzbekistan with the deposits of Almalyk and Kalmakyr carrying the greatest industrial significance. The Almalyk copper complex is among the largest copper producer in the U.S.S.R.

In a summary view, the main copper regions of the U.S.S.R.: Kazhastan, eastern Urals, Uzbekistan, Transcaucasus, eastern Siberia and Norilsk. Areas of minor significance are: Northern Caucasus, Western Siberia and the Kola

Peninsula. It has also been born in mind that the construction activities in the U.S.S.R. copper industry are an ongoing concern. Whether it is in the field of exploration, the opening of new mines, the construction of mills, concentrators and refineries, all indications point into the direction that the U.S.S.R. will remain in the fore-front of the world copper producers for several decades to come.

Copper Investment Activities in Africa

Cameroon

According to Table 16, which is based on the information provided by the Engineering and Mining Journal, the Alucam Corporation which is in the process of constructing an aluminum smelter at Edea is also to expand the capacity of a copper smelter by 34,500 metric tons of copper per year.[75] This expansion will cost $13 million, according to that source.

Morocco

Copper Mine Production (Concentrates, metal content)

1977: 3,400 metric tons
1978: 4,200 metric tons
1979: 8,225 metric tons

Morocco is a relatively small copper producer with ore coming from four different mines[76] and delivered in the form of concentrates.

However, the construction of a new copper refinery with a capacity to produce 17,500 metric tons of refined copper is underway. This refinery will be run by Somifer and the feed for the new refinery will come from a new mine which is being developed at Reida.[77] The cost of this project will be $65 million as shown in Table 16. Most of Morocco's copper, is of course, exported and exports may easily reach 25,000 metric tons per annum in the foreseeable future.

Table 16
Copper Investment Activities in Africa

Company	Location	Type of Proj.	Planned (Capacity) '000 metric tons	Actual (Capacity) '000 metric tons	What	Investment $ millions	Start	Comments
Cameroon								
Alucam	Edea	smelter	72.6/ year	38.1/ year	copper	130	1981	
Morocco								
Minere du Bou-Gaffer	Bleida	mine	50/ year	12.5/ year	conc.	65	1981	
South Africa								
O'okiep Copper	Carolusberg	Underground mine				69	1983	This expansion envisages a shaft of a depth of 1.718 km. to the Carolusberg Deep Orebody.
Uganada								
Kilembe Mines	Kilembe	mine& smelter	15/year		copper	23		Rehabilitating Kilembe mill and Jinja smelter.
Zaire								
Gecamines	Kolwezi	complex	100/year		copper		1983	DIMA project continued
Zambia								
RCM	Baluba	underground mine	11/day	5.5/day	ore		1981-1985	Replacement of depleting Luanshya mine.

South Africa — Copper Mine Production 1950: 33,200 (Namibia: 10,700)

1979: 194,370 (Namibia: 41,810)

Refined Copper Consumption 1950: Total Africa only 17,563

1979: 63,141

An almost six-fold increase in copper mine production marks the copper performance of South Africa whose copper comes from three different regions: a) the Northwestern Cape Province (Namaqualand), b) Northern Transvaal (Messina District), and c) Northeastern Transvaal (Palabora).

In total four companies operate in South Africa's copper mining industry:

1. O'okiep Copper Company Ltd,
2. Prieska Copper Mines (Pty) Ltd. both of which are located in the Cape Province[78]
3. Messina, Transvaal Development Company
4. Palabora Mining Company, Ltd., also in Transvaal.

Of these four companies the Palabora is operated on a massive scale with a refinery output based on Palabora ore steadily approaching the production capacity of 120,000 metric tons. This is inspite of a relatively low copper grade of 0.52 of one percent. This mine produces also important by-products such as magnetite, uranium concentrate and precious metals.

Given the revised ore reserves of 2.4 billion metric tons as published by the South African Department of Mines with an average grade of 0.26 percent of copper, the total

reserve would amount to 6.4 million metric tons of the red metal. At the annual production rate of 120,000 metric tons, these reserves alone would sustain this output level well into the next millenium.[79]

In light of the low ore quality, it is not surprising that the income performance of the main companies have experienced difficulties. At present, it is the O'okiep Copper Company which places an investment of $69 million to drive a new shaft of 1,700 metres (alomst 6,000 feet) to the Carolusberg Deep Orebody beneath the existing Carolusberg mine. The estimated ore reserve is 14.3 million metric tons with a grade of 1.93% copper. This mine should be in operation in 1983.[80]

Uganda

Eight years of rule by President Amin came to an end in April of the year 1979. The succeeding governments, at first under Mr. Ysufu Lule and, subsequently, by Mr. Godfrey Binaisa saw themselves facing the formidable task of rebuilding an economy plagued by foreign exchange deficits of about $600 million, general lawlessness in the country and widespread food shortages and cattle disease especially in northern Uganda. It was understandable that the mineral industry was very low on the list of priorities. Nonetheless, the new Ugandan Legislative Assembly started the promotion of a new National Mining Corporation to

coordinate prospecting, mining and mineral marketing.[81] This included the invitation of foreign investments to operate in Uganda though under state control. It was at this time that the rehabilitation of the famous Kilembe copper mine was announced with an allocation of $15 million, to this end.[82] Table 16 refers to this project in connection with the construction of a smelter and a total investment cost of $23 million. In addition, this announcement by the new Ugandan government also provided for the joint extraction by government and mining company of cobalt from millions of tons of mining pyrite tailings which had been piled up during twenty five years of operation. This general rehabilitation of the copper industry in Uganda becomes immediately understandable if one views the general production, and export performance of this country. The following breakdown gives the copper output as based on the general U.N. statistics and two export figures from the main reference.[83]

Uganda Copper Production
(Smelter Capacity 20,000 lt/y)

		Exports
1970	17,600	
1971	15,900	
1972	14,500	17,600
1973	14,200	
1974	11,600	
1975	8,500	
1976	23,100	
1977	10,800	8,277

The reserves of the Kilembe mine, which lies 300 miles north of Jinja and once had been owned by Falconbridge are 5 million metric tons of copper ore with a grade of 2 per cent. However, the mine was closed after its nationalization by Idi Amin.When Falconbridge sold its 73% to the Kilembe Copper Cobalt in 1975, the concentrator had a capacity to treat around 3,000 metric tons of copper sulphide ores per day and an additional blister copper capacity to produce 14,000 metric tons per year.[84] However, according to this more recent report, the attention will be centred on the reprocessing of the mining tailings rather than to expand copper production at Kilembe.

Zaire — Copper Mine Production 1950: 175,900 metric tons
1979: 400,260 metric tons

Refined Copper Consumption 1950: ---
1979: 1,180 metric tons

Due to transportation problems - the Bengui railroad had been closed in 1975 as had been the Mozambique-Rhodesian border - rising export and import costs, severe strains on foreign exchange and substantial financial problems in the mineral industry, the planned output for 1980 of 800,000 metric tons became a goal far removed from reality. In 1979 Zaire produced some 400,000 metric tons of copper and it will take some time to attain the set objective. With the end of the Rhodesian conflict, prospects have, of course, brightened the outlook for the copper industry.

Three companies dominate the copper picture in Zaire. They are:

1. GECAMINES (La Générale des Carrières et des Mines)
2. SODIMIZA (Société de Développement Industriel et Minier du Zaire)
3. SMTF (Société Minière de Tenke-Fungurume)

Another company of a somewhat smaller importance is

4. SIMZ (Société International des Mines du Zaire)

GECAMINES is the Zairian government-owned successor to the Belgian Union Minière du Haut Katanga with compensation provided to the former Belgian owners. The capacity of this company is, of course, much larger than the copper outputs which resulted in recent years. This state company is heavily active in copper exports which has proven the primary source of foreign exchange for Zaire. At present a $483 million expansion program is under way. This is the so-called Dima project financed by the World Bank under the supervision of the Société Générale des Mines. It will raise the copper production capacity of Gecamines by 100,000 metric tons of copper annually to 600,000 metric tons. This copper complex at Kolwezi should be ready by 1983.

SODIMIZA is a 20% Zairian government-owned company paired with an 80% ownership of an eight-firm Japanese consortium. The eight firms are: Nisscho-Iwai, Furukawa Mining, Toho Zinc, Mitsui Mining and Smelting, Sumitomo Metal

Mining, Nippon Mining, Mitsubishi Metal and Dowa Mining. Of these Nippon Mining appears to be the most important one in the consortium. Sodimiza produces about 2 million metric tons of ore annually which is transformed into (30 - 37%) concentrate and is shipped to Japan for refining. The total investment so far is about $150 million and the annual output is in the neighbourhood of 36,000 metric tons of copper.

SMTF started as a joint copper-cobalt venture with the Zairian government owning 20 percent. The remainder is allocated among the following companies: Amoco (28%), Charter Consolidated, U.K. and its associated companies (28%), Mitsui and Co. (14%), BRGM (3.5%), Omnium des Mines (3.5%), and Leon Templesman and Son (3.0%). This company basing its expectation on an ore reserve of 56 million metric tons with a grade of 5.6% copper and 0.46% cobalt, is aiming roughly at an annual output of 100,000 metric tons of copper which is 30,000 metric tons less than initially planned. The company experienced severe financial problems mainly due to the circumstances surrounding the Rhodesian crisis. A somewhat scaled down project which will cost $800 million and, over the life of the mine, will deliver 3 million metric tons of copper and 320,000 metric tons of cobalt.

Considering that Zaire had a basic capacity to produce 500,000 metric tons of copper per year, these two projects will add 200,000 metric tons to that potential,

at a cost of 1.235 billion. However, one has to bear in mind, that a considerable amount would have to be allocated in this appraisal towards the production of cobalt.

Zambia Copper Mine Production 1950: 280,000 metric tons
1969: 832,000 metric tons
1970: 835,000 metric tons
1979: 587,550 metric tons

Zambian copper output in 1979 was 587,000 metric tons, which meant a considerable decline over the amounts produced in 1969/70 brought about by depressed copper prices and the Rhodesian conflict, especially during the last five years in the 1970s. There is no doubt that the return of peace to this part of Africa will enable that country to regain its position as a copper and cobalt producer by exploiting its mineral potential to the fullest.

In order to promote industrial growth, the Zambian government has increasingly relied upon 5-year development plans. The second of these, which ran from 1972-1976 aimed at a growth rate of 6.8 percent per annum. The third which began in 1977 was postponed in its beginning and had been rescheduled to start in 1980. Besides the promotion of economic growth the Zambian government has tried to assure an ever-increasing Zambian participation in the economy. For this reason the government in Zambia has taken a controlling interest in a number of large firms, including, of course,

the mining companies. This control is exercised by the Zambian Industrial and Mining Corporation (ZIMCO), itself the holding company for the Industrial Development Corporation (INDECO) which is concerned with industry and distribution. The Mining Development Corporation (MINDECO) holds the government's 51% shares in the mines.

The Katanga-Zambian copper belt is the second largest source of copper in the world after the U.S.A. Since the U.S. consumes more copper than it produces Zambia has become the world's largest exporter of copper.

Zambia has three mining units with copper capacities. There are two major groups in the system plus a smaller mine (Kalengwa). The first group is the Nchanga Consolidated Group which produced 368,332 metric tons of copper in 1979. This company group operates five underground copper mines, ancillary milling and smelting facilities, two refineries, and a new cobalt leaching plant at Chambishi, the most successful of its recent operations which puts Zambia into the forefront of cobalt suppliers in the world.[85] The four most important copper divisions of this group are:

1. Rokana Division
2. Chingola Division
3. Kansanshimin Division
4. Konkola Division

The second group of copper mining firms is Rona Consolidated which produced 255,543 metric tons of copper in 1979. Its main units are:

1. Mufilira Division
2. Luanshya Division
3. Chibuluma Division
4. Chambishi Division

At present, the lowest grade, apparently, is mined by the Luanshya Mine where the grade has deteriorated to 1.50% copper. This is lower compared to the recorded prevailing grades ranging up to 5.9 (!) copper. And it is in the Roan Consolidated Mining group that $23 million (Table 16) are invested to raise the output of the Baluba mine by 100%, a mine which is part of the Luanshya Division. This mine extracted 1.683 million metric tons of ore in 1979 and one could expect therefore this output to rise to well over 3.2 million metric tons by 1985, raising the Luanshya Division ore total to over 7 million tons per year,[86] and increase the output potential by RCM by 24,000 metric tons of copper.

Copper Investment Activities in the Middle East

Saudi Arabia

Saudi Arabia enjoys the fortune of huge petroleum export surpluses as the petroleum industry dominates the Saudi economy. However, a view on to the map of this country in the Middle East cannot fail to leave the impression that a country of that size must have other mineral resources than only hydro-carbons.

Having initiated the third of its five-year programs which means a shot of $200 billion into the investment arm of the Saudi economy - the government of this country exercises a benevolent hand over the mineral mining industry but not without control. The position of Saudi Arabian mining is, perhaps, best summarized by a direct quotation from the Mining Annual Review, 1980.[87]

> «The Saudi government encourages the establishment of healthy minerals industry throughout the kingdom, by supportive geological exploration programmes conducted by or on behalf of the Ministry of Petroleum and Mineral Resources. The state entity Petromin has made direct investments and has encouraged the participation of foreign mining companies.
>
> The Saudi Arabian mining code established that all minerals are state property, with the granting of rights invested in the government. Private-sector exploration firms may receive exclusive licenses that guarantee a mining lease in the event of a commercial discovery. Foreign companies are expected to enter a joint venture partnership with a Saudi firm, usually with Petromin, on a 50-50 basis, exploration cost of both partners being capitalized.
>
> The Ministry of Petroleum and Mineral Resources has conducted an ambitious mapping programme on the Arabian Shield, an area of Precambrian rocks which contains a number of historically important gold, copper, and silver mines.»

It is in the Arabian Shield that a copper mine is contemplated by the Arabian Shield Development Corporation. Its mine will be located at Al Masane, with no further information easily available (Table 17).

Iran Copper Mine Production 1973: 1,000 metric tons
1979: 4,810 metric tons

Refined Copper Consumption 1979: 7,983 metric tons

Iran, whose copper mining output stood at 1,000 metric tons in 1973 succeeded to raise production to 4,810 metric tons which is more than half its domestic consumption need. Since Iran does have huge copper deposits it was decided that the National Iranian Copper Company built a smelter at Sar Cheshmen near Kerman, and to open up the deposit with a mine of 145,000 metric ton capacity of copper annually. Initially, Krupp-Mechim had been awarded the construction contract;[88] however, Anaconda had been in charge of developments.[89] After June 1979, Anaconda was dismissed which left the project surrounded in an air of uncertainly. The new Iranian government, however decided, to complete the project with a target date of 1984.[90] Iran will rely upon Yugoslavia which will supply some of the supervisory services formerly assigned to Anaconda.[91] The important point is that the turbulent events in Iran which stunned the world at that time, only meant a delay and that the most important copper project in the Middle East will go ahead and produce copper by the middle of the 1980s.

Table 17
Copper Investment Activities in the Middle East

Company	Location	Type of Proj.	Planned (Capacaity) '000 metric tons	Actual '000 metric tons	What	Investment $ million	Start	Comments
Saudi Arabia								
Arabian Shield Development	Al Masane	mine	2/day		ore			SNC of Montreal is under contract for processing and engineering design.
Israel								
Israel Chemicals	Timna	underground mine				15	1981	Reopening of mine.
Jordan								
Government/ BRGM	Wadi Araba	complex	27.2/year		copper	178		Feasibility:BRGM; Metallurgy:Seltrust.
Oman								
Government	Sohar	mine	1000/ year		ore	120	1982	
Turkey								
Etibank	Kure	open-pit & underground mine	100/year		conc.		1983	Contract:Finnish consortium;will a also mine 500,000 metric tons of pyrites.

Israel

Israel Chemical Limited (ICL) is involved in the extraction of materials from the Dead Sea as well as in the production of phosphates. In addition, it is also responsible for the rehabilitation of the Timin I and II copper mines at Eilat.[92] This operation had been closed down in 1976, and, upon restarting, it will deliver copper and manganese sulfates.[93] According to Table 17, the investment will amount to $15 million and the copper capacity of the mine is listed as 4,000 metric tons[94], a quantity which easily may be absorbed by Israel reducing its copper import dependence.

Jordan

Jordan is mainly a phosphate producer and the only other metal with some potential is a copper-manganese deposit in the Wadi al'Arabah region in the geographic-geological proximity of the Eilat deposit in Israel. Jordan's Natural Resource Authority is studying the area in cooperation with British Experts (Seltrust Engineering). With an estimated copper reserve of 60 million metric tons (3 million of manganese)[95] and after further geochemical testing to be carried out by BRGM, and according to Table 17, $178 million will be invested to exploit the deposit. The mine is expected to produce 27,200 metric tons of copper. For Jordan which is not high on the list of refined copper consumers, this copper may assist in developing a larger industrial base of the country or it may be channelled into the international copper markets.

Oman

Here is another country whose geographical dimensions escape the view of the general beholder. Geologically tied to Saudi Arabia, Oman enjoys the benefits of a prospering oil industry. However, this is not all. Other mineral deposits have to be added to the petroleum fortune, above all copper. Serious investment plans are proceeding in Oman which, through the prospecting work of Prospection Ltd., Canada, has discovered about 60 copper deposits.[96] The three largest of these are in the Oman Mountains at the Northern tip of the country, west of Sohar. Three different deposits totalling 12 million metric tons are under close scrutiny. Investment plans provide for a 3,000 metric tons per day concentrator and a smelter and fire-refining plant. At the outset, production is to be about 20,000 metric tons of copper[97] and the investment will be $120 million (Table 17).

The copper is of the so-called Cyprus-type variety and considerable further exploration will be necessary if operations of the complex are to continue after the first three Sohar mines will be exhausted in about 11 - 12 years time. What will happen with the 20,000 metric tons of copper which are produced annually? The answer is that if no copper related industry can absorb the material-and there is no refined copper consumption in the statistics-the copper will also be exported.

Turkey Copper Mine Production 1977:33,500 metric tons
1979:28,000 metric tons

Refined Copper Consumption 1977:29,030 metric tons

Turkey produces enough copper to serve its own domestic needs. The mining output comes from three of Etibank's units: Samsun (Black Sea), Ergani, and Murgul. The company also mines an additional 120,000 metric tons of copper pyrites per year at Kure. It is there that an expansion program is under way to raise the concentrator capacity by 245,000 and to bring it eventually to 500,000 metric tons (Table 17). The World Bank will extend a $200 million loan which is to finance this and other mineral projects. And this is just the beginning because the country of Turkey is very rich in numerous minerals which have not been properly exploited. It is also obvious that Turkey will export any excess of copper produced over what is domestically demanded by the copper-using industries in Turkey.

Copper Investment Activities in Central and East Asia

Burma — Copper Mine Production 1950: 100 metric tons
1979: ---

Burma produced about 150 metric tons of copper matte annually by the end of the 1970s. However, the Myanma Corporation is building a smelter at Salingyi to produce 60,000 metric tons of copper. The ore will come from the Myanma mine. The investment (Table 18) amounts to $134 million. For a country which has been dormant in the production of copper such a strong entry into the copper industry speaks for a dramatic change in the policy of this country. Unless Burma has plans for establishing a strong copper-using industry, most of the 60,000 metric tons of copper will be ready for export.

China — Copper Mine Production 1961: 80,000 metric tons
1979: 175,960 metric tons
Refined Copper Consumption 1961: ???
1979: 375,943 metric tons

Since China consumes about 200,000 metric tons of copper more than its mines produce, it has to rely on other sources, especially on imports. It is difficult to imagine that a country of the size of China with copper reserves known to be 50 million metric tons in copper content had only two medium sized non-ferrous metal smelters and a small number of very small plants to process copper ores. However, various contracts with Japanese and, especially, German

Table 18
Copper Investment Activities in Central and East Asia

Company	Location	Type of Proj.	Planned (Capacity) '000 metric tons	Actual '000 metric tons	What	Investment $ millions	Start	Comments
Burma								
Myanma	Salingyi	smelter	60/year		copper	70	1981/ 1982	With the aid of Yugoslavian finance; This project is undertaken in connection with the Monywa mine and concentrator development.
Myanma	Myanma	open-pit mine & concentr.	2,200/ Year		ore	54	1981/ 1982	Design and technology are being provided by Yugoslavia.
China								
CNTIC	Kiangsi Prov.	smelter	90/year		copper	116.8		To be built by Sumitomo.
CNTIC	(in China)	complex				800		Mine&smelter&refinery.The Fluor Mining and Metals Corporation has obtained the contract for the first stage of the project.
India								
Hindustan Copper Ltd	Malanjkhand	open-pit mine & concentr.	23/year		copper	116.4		
Pakistan								
Resource Development Corporation	Saindak	complex	16/year		blister copper	250		Production includes molybdenum,gold, silver,H_2SO_4, and steel.
Government	Saindak	open-pit mine	12.5/day		ore	200	1984	contains the above given metals.

firms will slowly change this picture of industrial underdevelopment.

Sumitomo Metals will build a 90,000 metric ton fully integrated flash smelter while the German Metallgesellschaft A.G. and Lurgi are to supply a total of 22 plants. The Australians are said to be involved in building a pilot plant while even the Finnish metal expert firms may enter the scene just as they have in the U.S.S.R.

With huge copper deposits at the disposal China has awarded a contract to the Fluor Corporation of the U.S.A. to construct a copper mining plant to produce 250,000 metric tons of copper. This plant should be in operation by 1983. Some of the deposits related to this project contain other metals than copper such as molybdenum and precious metals; and even rhenium has been mentioned in this context.

There are a number of significant copper deposits in China which are worth mentioning. The Tehsiang copper deposit has a copper reserve of 8 million tons of copper content while the Chinchuau deposit (Western Kansu) is estimated to hold 3.5 million tons. There are mines in operation in both areas.

There are also substantial skarn-copper mineralization in the lower and middle regions of the Yangtze River (1.5% copper and 1% zinc). The Yunnan Province is also known for its copper. This is especially relevant, since recently,

a large copper-iron occurrence was discovered in the same region containing also cobalt and other precious metals. Another two areas with known copper reserves are the Anhwei Province and Tibet where a 7 million ton copper reserve was discovered in 1979. A nickel-copper sulfide deposit has also been discovered in Gansu with a medium sized mine already in operation.

Besides bringing its own copper industry into full operation, China has to rely on the imports of copper from other countries, with which it has contracts. Such countries are: Chile, Peru, Zambian, Papua New Guinea, and the Philippines.

A distinct secrecy surrounds the mineral operations of China as much as many other interesting activities of this Asian Country. It is therefore difficult to conclude exactly how much is being invested and the degree by which the copper capacity of this country may actually be expanded. But it is clear that China will raise its copper processing and mining capacity to over at least 515,000 metric tons of copper by 1983. Whether this is more than China needs for its domestic consumption is even more difficult to guess. At best, by then, it will be producing as much as it consumes. Likewise, the total investment spending in the industry may only be derived peripherally. As may be seen in Table 18, China appears to be willing to invest $916.8 million in the copper industry.

India	Copper Mine Production	1950:	9,200 metric tons
		1979:	30,290 metric tons
	Refined Copper Consumption	1950:	31,480 metric tons
		1979:	51,710 metric tons

Evidently, India's copper mining output grew by the same quantities as its refined copper consumption, iz. both rose by about 20,000 metric tons over the period from 1950 to 1979, as may be seen from the above-given statistics. This also implies that the persistent gap by which consumption exceeded mine production, then as much as now, had to be filled from other sources such as secondary metals, scrap and imports. This gap, as followed from the general statistics used for this study, may, however, still be an underestimate G.R. Seshadri places the difference for the 1979 at 80,000 metric tons with imports running up to 70,000 metric tons.[100] There is no way here to decide which of the two estimates is closer to the truth; yet the fact remains that there is a significant deficiency in the Indian copper output versus its consumption.

India's copper reserves stand at an estimated 366 million metric tons of ore with quite a number of deposits spread through the country. One area alone Malajkhand, holds 60 million metric tons with a grade of 1.24%. It is towards this deposit that the public-sector Hindustan Copper Corporation has turned its attention. As the only copper processing company in the country, it has definite investment plans

for these deposits. A sum of $116.4 million (Table 18) will be invested to raise the output by 23,000 metric tons of copper. A further 5,000 metric tons will come from Chitradurga company which sell its copper concentrate from three mines to the HCL for processing at Ghatsila.

Efficiency measures recommended by experts from the Furukawa Corporation of Japan have already led to a better utilization of existing capacity at the second, Khetri, complex of the HCL; this complex consists of a mine, concentrator, smelter, refinery and an acid-plus-fertilizer plant. Implementation of the Japanese recommendations led to an increase in output by 7,000 metric tons at this plant. In this fashion, India is seriously trying to cope with a very difficult problem of reducing a relatively strong copper-import dependence.

Pakistan

Copper has not been a mineral of significance in Pakistan which is known for its scarcity in minerals generally. However, recent developments indicate that Pakistan will produce copper in the foreseeable future.

Pakistan disposes of at least 312 million metric tons of (0.366% copper) and magnetites at Saindak such that two major mining projects have been planned to be on stream in 1984 (Table 18). These plans involve a steel making operation as well as a complex to produce non-ferrous base

and precious metals. The Resource Development Corporation has contracted the Mountain States Mineral Enterprises Corporation of Tuscan, Arizona, to present a feasibility study and initial engineering plans for both processing of non-ferrous metals and the steelmaking with the aim to secure funding.[101]

In turn, the United Nations Development Program has commissioned an evaluation of operation tests run by Allis-Chalmers and by Pullman Swindell on the processing of Saindak deposits.[102]

Following Table 18, the two projects would see, at first, the start of a mine to extract the poly-metallic ores; and second, the facilities to process the minerals, steel and sulfuric adic.

The total investment would be $450 million of which some undefined part would have to be allocated toward the copper production. The expected output would amount to 16,000 metric tons of blister copper per annum serving this developing country either through direct usages or through exports of copper or, most likely, through both.

Copper Investment Activities in Australasia

Australia — Copper Mine Production 1950: 15,300 metric tons
1979:229,290 metric tons
Refined Copper Consumption 1950: 17,870 metric tons
1979:124,830 metric tons

In 1950 Australia consumed slightly more copper than its mines produced. By 1979, copper mining output was almost double its domestic refined copper consumption demonstrating the way of developments in Australia's copper industry.

A number of copper mines were expected to start operating in 1980/81. The poly-metallic Que River deposit to be exploited jointly by Aberfoyle Ltd. and Paringa Mining has a very small copper capacity. It should produce between 600 - 800 metric tons of copper.[103]

Peko-Wallsend Mining Company is reported to start mining ores (1980) from the Tennant Creek deposit at Mount Morgan. The total capacity would correspond to a production of 18,000 metric tons of copper per year besides valuable gold recoveries. These increased mining activities at the Warrego and Gecko mines with 4 million metric tons containing 3.4 percent copper led to a reopening of the Tennant Creek copper smelter which produced its first blister copper in 1980, with excellent results. The Tennant Creek mining operations is a welcomed support to operations at Mount Morgan whose reserves were running low

Table 19
Copper Investment Activities in Australasia

Company	Location	Type of Proj.	Planned (Capacity) '000 metric tons	Actual (Capacity) '000 metric tons	What	Investment $ millions	Start	Comments
Australia								
Western Mining BP Australia	Roxby Downs,SA.	mine/ plant	150/ year		copper	1,000		Includes uranium and gold with an exploration shaft started in July 1980.
Indonesia								
Freeport Indonesia Inc.	Irian Jaya	under-ground mine	9.5/day (original; in reverse order)	4.5/day	ore	100	1982/ 1983	Concerns the Erts-berg East orebody.
Philippines								
Black Mountain	Baguio	conc.	10/day	3.2/day	ore	16.5	1982	
CDCP Mining	unspecified	conc.	25/day	15/day	ore	31	1983	Copper concentrate with gold, silver & molybdenum as by-products
Delta Mining	Hinobaan	mine	20/day		ore	200	1983	the ore reserve amounts to 98,400,000 metric tons with a 0.5% copper gr.
Hercules Minerals and Oils	Ilocos Norte	mine& conc.	3/day		ore	12.5	1981	1% supposed copper gradee.
Marinduque Mining and Industrial Corporation	Sipalay	conc.	30/day	18/day	ore	94.4	1982	Related to nickel refinery.

(continued)

Table 19(continued)
Copper Investment Activities in Australasia

Company	Location	Type of Proj.	Planned (Capacity) '000 metric tons	Actual '000 metric tons	What	Investment $ millions	Start	Comments
Philippines								
North Davao Mining	Davao del Norte	Mine& conc.	25/day		ore	100	1981	Outokumpu is leading the construction consortium.
Philippines Associated S & R	Leyte	smelter	150/year		copper	250	1983	Marubeni obtained the construction contract.
Papua New Guinea								
Government& MIM Holdings	Freida R.	mine						Ore reserves are estimated to amount to 500,000,000 metric tons of 0.5% copper.

such that the smelter has to be fed by the Chalmers Mine 37 miles away. Even that life span seems to be ending in the foreseeable future.[104]

Of course, this is not the only project. There is for instance Mareeba Mining. It will begin the development of its small but rich Dianne copper mine in North Queensland. Or take the most important project on the Australian copper scene: Roxby Downs (Olympic Dam). British Petroleum has selected Western Mining for its partner with the aim to extract copper, uranium and gold (Table 19). $1 billion will be invested adding 150,000 metric tons of copper to Australia's output potential,[105] besides the 18,000 metric tons to be expected annually from the Tennant Creek operations. It would place the Roxby Downs complex second behind the Mount Isa operations which, sofar, had supplied 75 percent of Australian copper.

Indonesia	Copper Mine Production	1973:	37,900 metric tons
		1979:	60,950 metric tons
	Refined Copper Consumption		---

The Freeport Indonesia Corporation operates a copper mine at Gunung Bijih in Tembagapura in the Jayawijaya Mountains of Irian Jaya. This mine produces concentrates containing 60,210 metric tons of copper, shipping 168,634 metric tons of concentrates in 1979.[106]

It is this company which tries to exploit a recently discovered orebody of 46 million metric tons at the Gunung Bijih Timur mine. This orebody contains 2.64 percent copper

which is better than the copper grade prevailing at the main place of operations.[107] The planned investment in this the Ertsberg East mine amounts to $100 million (Table 19) and it will help to extend the life of the Freeport operations at Gunung Bijih by another 15 years.

There is another company with development prospects: Aneka Tambang; it discovered two new copper orebodies in South Sulawesi amounting to 6 million metric tons of ore with a grade ranging between 0.5% and 3% copper.

In short, Indonesia's continuous contributions to world copper production appears assured through the opening of the Ertsberg East orebody by 1982/83. However, the Gunung Bijih mine is expected to be depleted by 1984.[108] This may usher in a net reduction of 30 percent of capacity of the Freeport Indonesia Company after 1985, unless additional ore is discovered in the meantime.

The Philippines Copper Mine Production 1950: 10,400 metric tons
1979: 296,980 metric ton
Refined Copper Consumption 1950: ---
1979: 5,990 metric tons

The Philippines mine copper ore and export copper concentrates. This means simply that the copper scene is characterized by extractive rather than the processing of copper as most of the investment projects still are mining oriented (Table 19) Atlas Consolidated and Marcopper are the

two largest copper mines in this island country.

After somewhat difficult times the copper producers were able to clear inventories through significant purchases especially by Japan, the U.S.A., Europe, Korea and,recently, China.

A new contract was agreed upon between the governments of the Philippines and China in which the Philippine authorities committed its industry to sell 70,000 metric tons of copper annually to China.[109] However, even with the new mines that have come[110] and will be coming on stream (Table 19) supply shortages still seem to be in the offing. That is why the Ministry of Industry of the Philippines had to negotiate coverage of its forward contracts with foreign suppliers. It is therefore of interest that mine production and output of concentrates are being stepped up in face of existing locationally close demand for the products.

As in most copper mining countries, an interest, soon developes, with or without political pressure, towards the production of refined copper. The Philippines are no exception in this respect. Their first copper and refinery project at Isabel in southern Leyte is to be on stream by 1983 with a planned capacity of 150,000 metric tons of copper (Table 19). The Philippine government will put up front $35 million of the $250 million necessary (Table 19) while the Japanese Marubeni consortium will invest $30 million. The World Bank has obtained a $5 million equity position in the project and will contribute towards the financing of this important copper complex.

There is no doubt about the copper reserves of this country especially about the known acknowledged 4 billion metric tons of ore for its at least 17 copper mines.[111] By 1980 standards 12 new mining projects were in progress adding 187,000 metric tons to an existing capacity of 245,000 metric tons of copper,[112] a spectacular increase of about 75 percent which closely matches the expansion ascertained during this discussion.

Some of the Philippine companies dispose of impressive reserves by any standard of comparison. Atlas Consolidated commands 900 million metric tons of ore while Marcopper has 101.2 metric tons at its original site and 200 million metric tons of ore at the San Antonio project.

In short, the Philippines will continue to supply the world with annually increasing amounts of copper as long as the market wants the metal.

A targeted investment of $1.5 billion will result in an increase of mined copper by 75 percent and an entirely new process capacity of 150,000 metric tons of refined copper by the middle of the 1980s.

Papua New Guinea Copper Mine Production 1950: ---

1979: 170,790 metric tons

Refined Copper Consumption 1978: 198,560 metric tons

1979: ---

Papua New Guinea is a scarcely populated and geogra-

phically rugged country making successful prospecting a very difficult and risky enterprise. Rich in gas and poor in oil, Papu New Guinea has become an important copper producer with copper concentrates going, under contract, to Japan, Western Germany and Spain.

Table 9 assigns 16 million metric tons of copper as the known, short-run metallic reserves to this country. Three major deposits may be distinguished. They are:

1. The Bougainville property at Panguna which is the only active mine in Papua New Guinea and responsible for the recorded output. The ore reserve was about 690 million metric tons delivering 0.52% copper by the end of 1979.

   Since annually about 35 million metric tons of ore are extracted,[113] this mine has a life span of at least another 20 years.

2. The second deposit is at Ok Teli in the Star Mountains near the Irian Jaya border. Before 1975, Kennecott Copper and, later, the Ok Tedi government agency did exploratory work on a 250 million metric ton ore site containing a grade of 0.85% copper.[114] This project which envisioned the construction of an entire copper complex is not presently on the list of ongoing investments (Table 19), but it should not be lost out of sight. Some time in the future

it may become feasible as copper prices will be continuing to rise.

3. The third is a project for which $440 million have been estimated as necessary is to bring the Frieda River deposit into production (Table 19). It contains 500 million metric tons of ore of 0.5% copper content. Such a low grade may prove an obstacle to successful exploitation should weaknesses in the world copper market persist for a long time.[115]

In short, ore reserves amount to 1.4 billion metric tons, and should the Frieda River deposit be put on stream, Papua New Guinea's future copper output could be increased substantially, though it is not possible, at this point to state exactly by how much. Since this country is far from fully explored the likelihood is great for additional copper ores to be discovered in the future. No doubt, even the Ok Tedi deposits will one day be mined.

SECTION V: THE FUTURE OF COPPER PRICES, PRODUCTION, AND CONSUMPTION

Copper Prices

Historical Prices

In the United States the price of copper was 29.57¢/lb. in the year 1860. It declined slowly at first to 27.7¢/lb. in 1869, dropping suddenly to 18.6¢/lb. in 1870 only to jump to 30.8¢/lb. in 1872. The decline resumed with some variation over the years to record 9.13¢/lb. in 1894, the lowest point before the turn of the century as shown in Exhibit 1.

Hence, it started to rise gently reverting to the previous trend with some major though temporary rise to 29.28¢/lb. during the First World War. Afterwards it returned to a low of 12.98¢/lb. but continued the new upward trend. With the depression of the 1930s, annual copper prices reached a sudden historical low of 5.91¢/lb in 1932, and ever since, the prices have been on the rise. During the Second World War, the price was fixed at 12¢/lb.

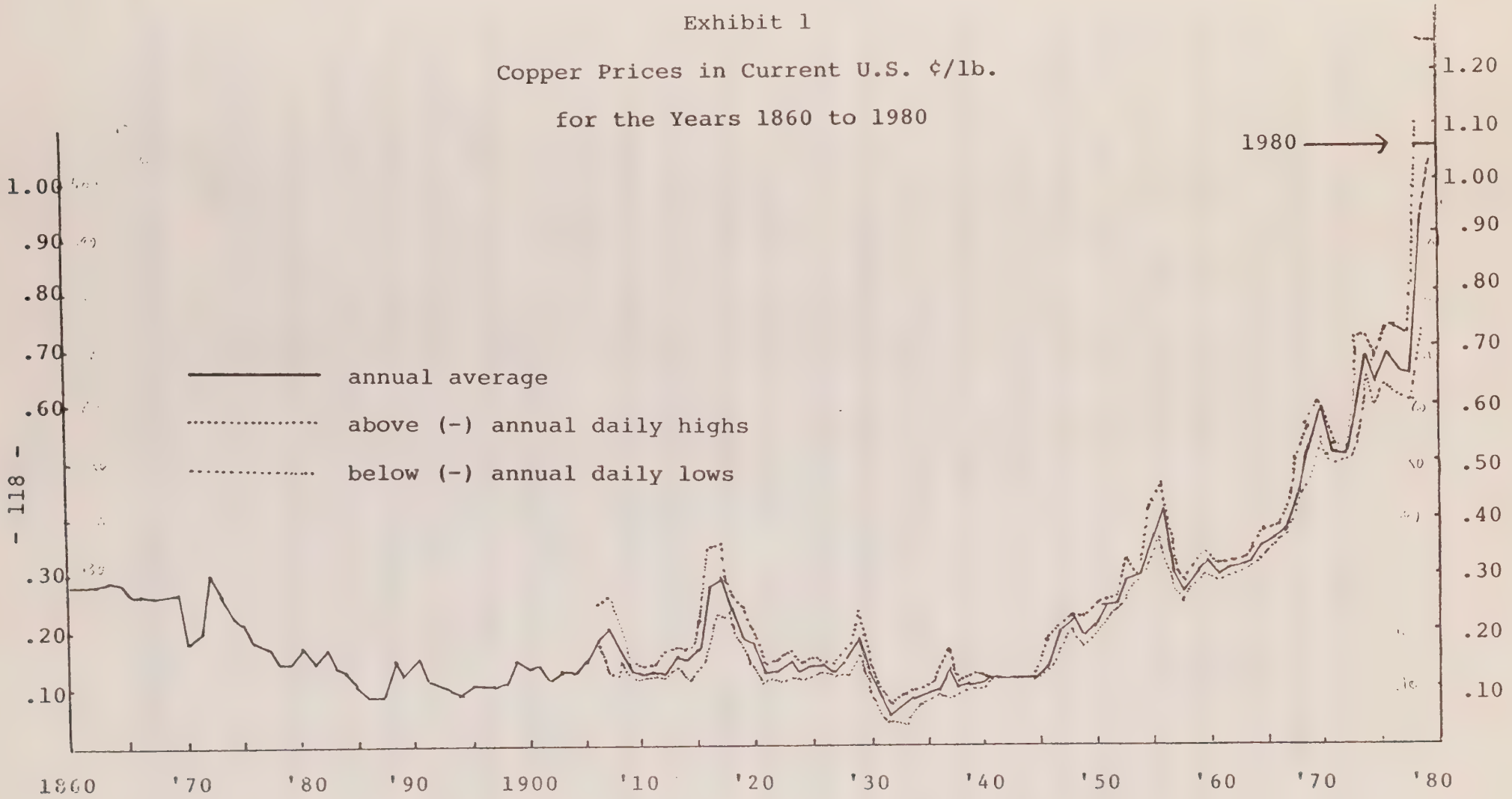
Copper prices accelerated breaking out from the general trend line during the time of the Korean conflict and it was in 1956 that the price for the red metal hit 41.98¢/lb. for the first time. Nonetheless, it did return to lower levels and, by 1961, had fallen to 31¢/lb. which was close to the level it had held one hundred years before.

In the following years, there was no further setback. Copper prices followed the upward trend advancing

Exhibit 1

Copper Prices in Current U.S. ¢/lb.

for the Years 1860 to 1980



Source: Same as Bilver. Ch. II p.

steadily at an increasing rate over time. By 1970, the price reached 58.91¢/lb. settling back to 50.78¢/lb by 1972; and then it took off to average 93.33¢/lb in 1979 with the daily high and low during the year scoring $1.10 ,/lb. and 73.22¢/lb. respectively.

Future Prices

The main trend of copper prices in the future is set out in Table 20 and Exhibit 2. From $1.05/lb. the price of copper will rise by over seven cents between 1980 and 1981. Afterwards copper prices will climb at almost constant annual increments until 1990 when it will cost $1.52/lb. Naturally, market prices will differ due to inflationary, recessionary and other, mostly political circumstances which influence market behaviour. These circumstances are beyond the predictive ability of the econometric model which is aligned to the real basic economic conditions of the copper mining industry on a global basis.

After 1990 the confidence placed by the analysts in the reliability of the forecast cannot be quite as strong as for the first decade of the forecast period. Therefore, it is reasonable to assume that by 1995, copper will sell for $1.84/lb. and two years later it will stand at $2.00/lb. The year 2000 is expected to record a copper price of $2.26/lb. and at the end of the forecast period, its price tag will be $2.67/lb. in constant 1979 U.S. dollars, without obligation of the analysts.

Table 20

Copper Prices in Constant 1979 U.S. Currency

World Production and Consumption of Copper

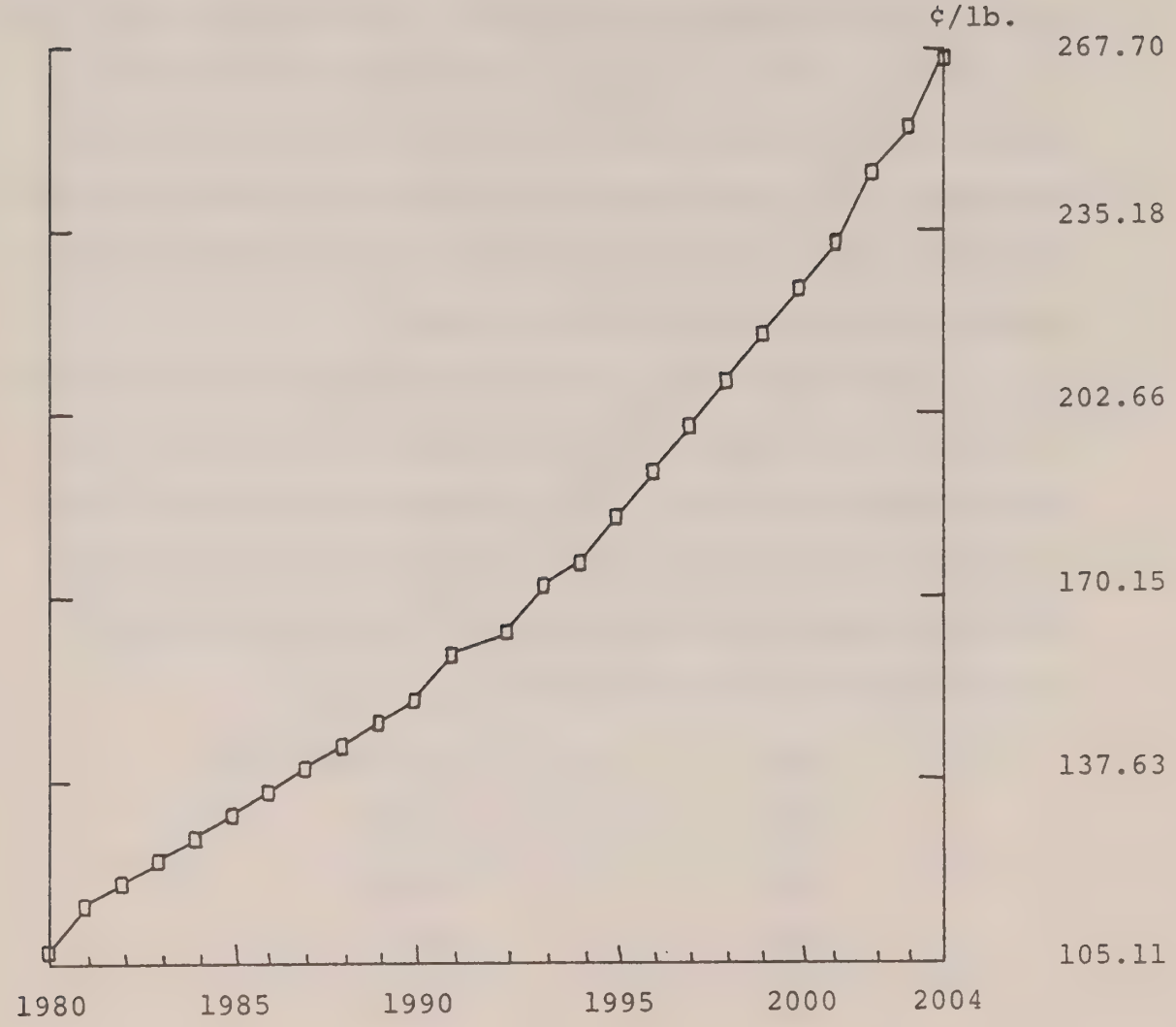
for the Years 1980 to 2004

Year	Prices ¢/lb.	Production	Consumption
1980	105.11	8,261.39	9,013.53
1981	112.60	8,640.85	9,382.99
1982	117.62	9,029.38	9,759.39
1983	121.50	9,418.49	10,134.77
1984	125.03	9,805.69	10,506.87
1985	128.64	10,191.59	10,876.35
1986	132.52	10,578.14	11,245.09
1987	136.77	10,967.69	11,615.29
1988	141.42	11,362.51	11,989.05
1989	146.46	11,764.57	12,368.17
1990	151.88	1,2175.51	12,754.13
1991	157.67	12,596.68	12,148.09
1992	16.381	13,029.14	13,550.98
1993	170.31	13,473.80	13,963.55
1994	177.16	13,931.38	14,386.38
1995	184.38	14,402.55	14,820.00
1996	191.96	14,887.89	15,264.84
1997	199.93	15,387.95	15,721.32
1998	208.29	15,903.26	16,189.83
1999	217.07	16,434.35	16,670.73
2000	226.27	16,981.74	17,164.41
2001	235.92	17,545.92	17,671.18
2002	246.03	18,127.32	18,191.34
2003	245.61	18,726.42	18,725.20
2004	267.70	19,343.70	19,273.08

Exhibit 2

World Copper Prices in Constant 1979 U.S. Currency

for the Years 1980 to 2004 ¢/lb.



Future Production

Copper mine production will rise from 8.26 million metric tons in 1980 to 10.2 million metric tons by 1985; this production prediction may be seen in Table 20 and in Exhibit 3. In the year 1990 copper mine outputs will reach 12.175 million metric tons. The year 1995 will see 14.4 million metric tons of copper extracted from the earth and by the year 2000, 16,981,000 metric tons will represent the demand for mined copper. At the end of the forecast period the annual exploitation of copper mines will amount to 19.343 million metric tons.

This means that annual output between 1980 and the year 2000 will rise by 105.5 percent. In short, it will double; four years later, the increase over the year 1980 will be 134.1 percent. The following breakdown tells of how much copper will have been removed from the ground cumulatively during this period.

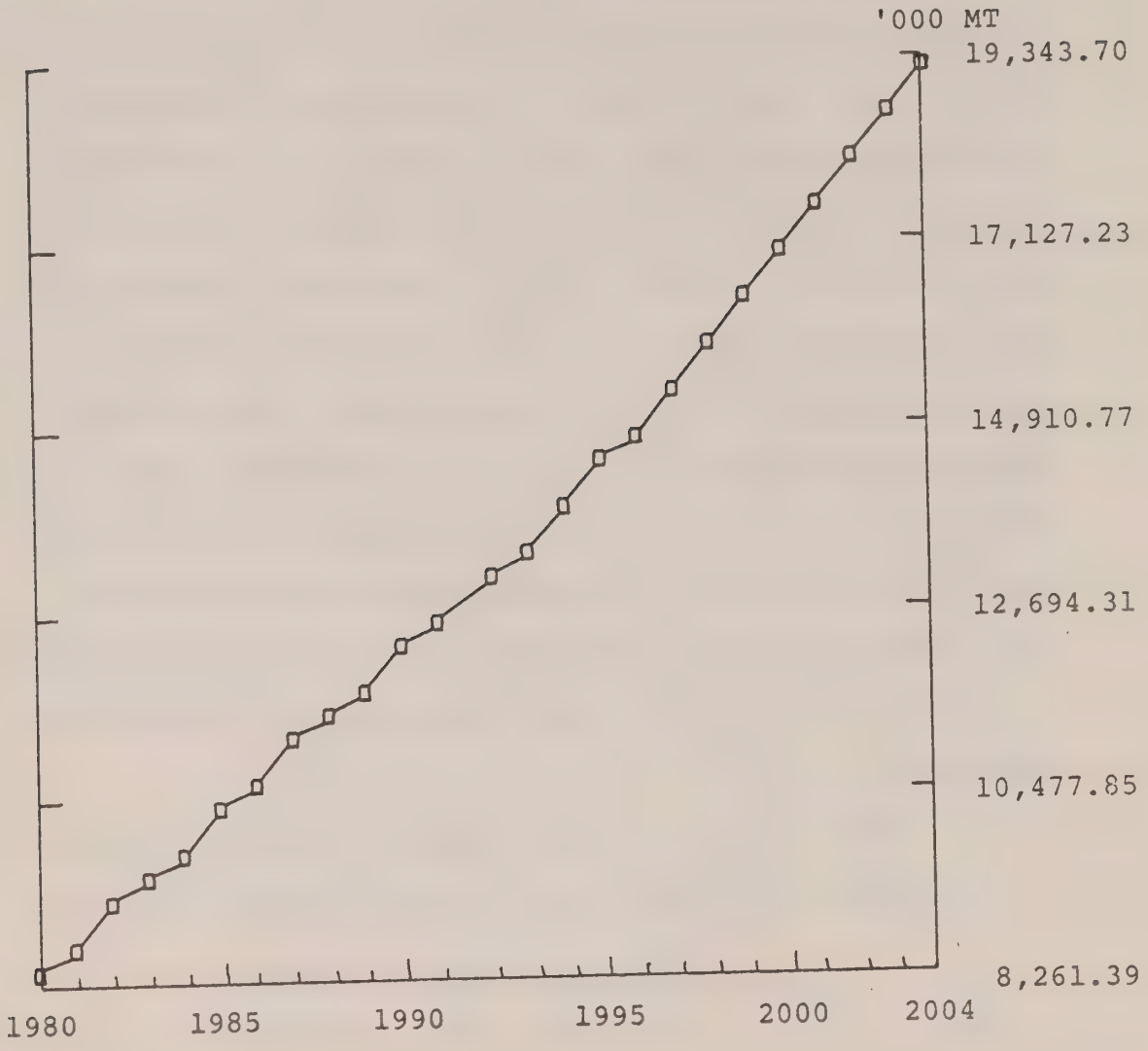
Year	Million of metric tons
1985	55.3
1990	112.2
1995	179.6
2000	259.2
2004	332.9

By the year 1985 55.3 million metric tons will have been extracted. Five years later about double that quantity will have been mined. With the beginning of the next century,

Exhibit 3

Copper Mine Production of the World

for the Years 1980 to 2004 in '000 metric tons



almost 260 million metric tons of copper will have been removed while the hypothetical total of 333 million metric tons marks the total recovery of copper over the entire forecast period.

Future Consumption

In essence, the figure of future refined copper consumption as given in Table 20 and Exhibit 4 follow the production figures very closely. They are presistently above the figures of future mined copper, at least until the year 2003. By then, the two variables, according to the econometric model, will have converged when mine supply equals consumption of the refined metal. In light of the increasing proportion in the use of secondary copper, this convergence is not valid. The consumption behaviour, as predicted for 1990s and beyond, has to be rejected on the grounds that the consumption variable is serving mainly a technical function to close the system of mathematical equations.

This forecast may be compared to other forecasts. The following break-down provides the necessary details.

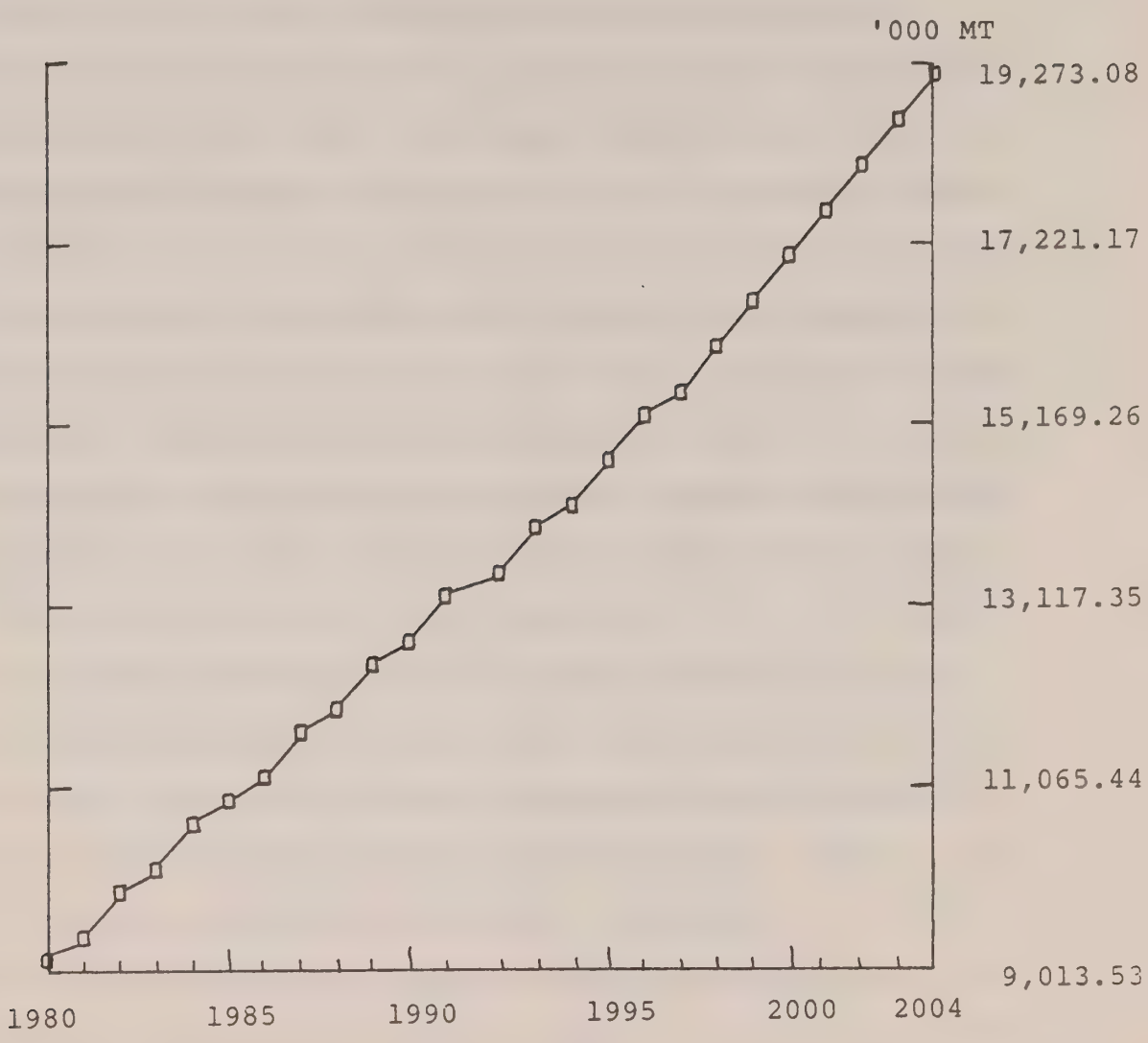
('000 metric tons of copper)

Year	Dr. E.T. Willauer	Dr. Malenbaum[116]	U.S.B.M.[117]
1985	10,191.6	11,341.3	11,521.4
2000	16,981.7	16,839.0	20.139.8
		maximum	24,222.2
		range	
		minimum	14,152.3

Exhibit 4

Copper Consumption of the World

for the Years 1980 to 2004 in '000 metric tons (technical variable)



For the years 1985 this forecast displays lower values than the other two predictions, the difference being 11.3% and 13.0% for Malenbaum's and that of the U.S.B.M. respectively.

Regarding the projections for the year 2000, this forecast exceeds Malenbaum's by 142,700 metric tons or by an error of (-)0.84 of one percent. They are almost identical although arrived at by two completely different methodologies. However, both predictions are very much below the forecast established by the U.S.B.M. The difference here is more than 18.5 percent. Yet, both still lie inside the forecast range which allows for deviations from tne norm. Since the Willauer and Malenbaum predictions are closer to the minimum, it may be argued that the forecast of the U.S.B.M. is upward biassed.

With respect to the future consumption some interesting points should be brought into focus. In the electrical field, factors such as safety, comfort , recreation and a less polluted environment will require substantial outlays of electrical equipment. This requires copper and the increasing consumption of this metal is accentuated by the ever-increasing cost of fossil fuels encouraging substitution by other energy sources. Electricity will be one of the most important substitutes. It will be transmitted over large distances covering also geographically larger and more densely populated areas. On these counts, the consumption

of copper is bound to rise, especially if power distribution systems will be taken underground to a much larger degree than is the case today.

However, some countervailing forces will exert a downward pressure on this positively oriented consumption of copper. Aluminum and copper-clad aluminum wires will serve as important and effective copper substitutes. New and advanced power generating systems which, in the opinion of Schroeder,[118] will not require generators, and cryogeneic techniques used in the transmission of power will reduce the upward pressure on consumption. Break-throughs in communication circuitry and fibre optics as well as satellite communication will economize on the use of copper as we do stand on the threshold of a development in communication unthinkable ten to fifteen years ago.

In the construction field, rising population, rising consumption and entrenched standards of living will contribute to a sustained growth of demand for residential housing and the use of copper on a large scale.

In the area of industrial usage of copper, especially in the field of industrial machinery, mammoth energy generation projects, from the 'small' Athabasca Tar Sands projects in Canada to the $500 billion investment proposal by EXXON to exploit the oil-shales deposits in Northwestern Colorado[119] - to name two - no doubt, will spill over into a substantial rise in copper consumption. How-

ever, North America, is not alone in the field. All industrialized countries and those on the road leading towards rapid industrialization, as, for example, China will accelerate the demand for copper.

Naturally, some countervailing factors may enter the market here as well. For instance, multi-unit dwellings may help economize copper absorption. Also a variety of substitutes may enter the industrial use in replacement of copper. Nonetheless, one should not forget that copper is of a unique quality as discussed in Section I and it is an attractive metal with great appeal to the sense of beauty of the individual. Eventually, it will reappear to a larger degree in decorative household utensils and implements than presently is the case. A rise in the price of silver and its substitutes may promote the home-demand for copper. and, last but not least, the field of transportation will not fail to utilize copper to a very large extent. Modern society cannot function as it does and as it is expected to do without copper and its alloys now and in the future.

SUMMARY AND CONCLUSION

Due to its qualities of tenacious malleability and high heat and electric conductivity this fairly abundant metal among all the base metals is high on the list of metals used by men; it is without an entirely satisfactory substitute.

In the United States wire and brass mills have become the main users of the unwrought refined copper. Over recent years wire mills displayed a distinct preference for cathode copper over wire bars while brass mills continue to be chiefly users of secondary copper.

World consumption of refined copper tripled during the period under study with a tendency in the world to use relatively larger quantities of secondary copper.

Among the copper consuming nations in the world, the United States is still in first place as its largest user. In 1979, copper consumption on the American continents and in Europe were almost the same. They were followed by the centrally-planned economies, and then, by Asia, where Japan displayed the most dramatic expansion of any country in the use of copper in the world. Australasia and Africa are the smallest copper consuming regions of the world. Of special interest was the observation that countries on the road towards industrialization exhibited impressive rates of rising copper consumption which are much larger than those recorded for the customary and established copper users such as the U.S.A., Canada and the United Kingdom.

World production of mined copper rose slightly less than the consumption of refined copper. The output of its 55 mining countries tripled during the period under investigation. A production peak occurred in 1977 while the end of the 1970s proved unsettling for the copper mine producers. This was especially noticeable for Canada and Ontario, producers of world stature, whose production shares in the the world shrunk during those years.

The most important copper mining countries still are: the U.S.A., the U.S.S.R., Chile, Canada, Zambia, Zaire, and Peru. They account for over 70 percent of the world total with other countries such as Australia, Poland, and Papua New Guinea establishing themselves as significant producers of this metal.

Canada increased its annual net export earning of raw and refined copper and alloys to almost $1 billion whereby decreases in refined copper exports and increases in the exports of ores, concentrates and matte could be observed. In the exports of raw copper materials Japan is the most important and the Soviet Union the unexpected second most significant customer.

In the field of copper smelting and refining, the United States leads the countries of the known processing world with about equal shares for both, just as Zambia. The United States could smelt and refine about 30 percent of the western world's ores. Canada in turn, is more

important as a copper smelter than as a refiner, whereas Japan and Belgium and most of the Western European countries are rather refining than smelting-oriented. This observation confirms a basic economic theorem which sees smelters in supply-oriented locations (at the mines) while the refineries are found in market-oriented locations (where copper is used); the only difference is that this behaviour is recognized on a global scale and not only true for a specific country.

The short-run reserves are 580 million metric tons of copper content including 30 million metric tons of seabed nodules. The long-run reserves account for about 1.5 billion metric tons exclusive of the immense quantities of copper contained in seabed nodules. The United States, Chile, the Asian region, Canada, the U.S.S.R. and Zambia are the largest holders of copper reserves. Nonetheless other countries such as Australia, Indonesia, Papua, the Philippines, New Guinea, Peru, Poland, have substantial known copper reserves, even in the long run.

World wide investment in copper production capacities including, of course, projects where copper is a joint product or even a by-product, amount, in a rough form, to about $25.4 billion. This figure is strongly upward biassed due to the joint product condition. However, it is also understated because for a considerable number of planned projects the financial expenditures could not be included.

The investment activities by region sees South America with 51.9 percent on top of the list, followed by North and Central America with 14.4 percent including Canada, Australasia 11.8% percent, Central and East Asia 6.36 percent, Africa 5.67 percent, Western Europe 4.9 percent, Eastern Europe 2.96 percent and the Middle East with 2.02 percent.

The investment in mining would go towards the production of additional 2.97 million metric tons of copper. However, it appears reasonable to consider this figure an underestimate as a number of processing projects do also include substantial additions to the capacities of ore production. The addition to processing capacities - a field which has experienced substantial under utilization in recent years - adds up to 2.7 million metric tons of processed copper. Unfortunately, a certain though undetermined amount of double counting and overlapping took place as smelter and refinery capacity have been combined and were not properly specified through the term: copper complex.

Whereas North and Central America stress the expansion of the output of copper mines, South America, Eastern Europe including the U.S.S.R., Central and Eastern Asia, Africa and even the Middle East stress the construction of processing facilities. The U.S.A., Australasia and Western Europe do not seem to be keen on expanding their smelting and refining capacities now as the others are. However, there is a clearly observed indication of the copper consuming countries

with substantial copper import imbalances that they will try and replace imports or at least to supplement domestic copper consumption from domestically mined copper.

Copper prices will rise by 1.42 percent over the actual annual copper price of 1979 - or by 130 percent over the simulated (true) 1979 price by the year 2000, and by 186.8 percent (172.4 percent (true)) four years later.

With the beginning of the 21st century 16.981 million metric tons will be produced annually and 19.343 million metric tons four years later. This means that by the year 2000 annual output will have more than doubled over the output of the peak year 1977. The cumulative totals of 259.2 million and 332.9 million metric tons will have been taken from the ground between 1980 and the years 2000 and 2004 respectively.

In conclusion, copper consumption will continue to expand at a greater rate than the output of mined copper, because demand may rely on ever larger quantities of copper in the hand of men. Especially, developping and rapidly industrializing nations will progressively add to the rising demand pressure for refined copper. Since electricity will be the main energy substitute for fossil fuels, expansion of transmission systems will be the most important future source of that demand which may be partially reduced by known substitutes of questionable reliability.

The world copper mines will extract somewhat more than twice the amount of the copper extracted in 1977 when

when 8 million metric tons were mined.

A number of questions arise in this context: a) Is there enough ore in the ground to support such an output volume? b) Are there any signs that this goal can be accomplished? c) Will the world have the capacity to process these ores?

The answer to these three questions is an unmistakable «yes». As to the first question, there is no shortage in ore reserves on this planet. Even if 260 and 333 million metric tons will have been cumulatively extracted by the year 2000 and 2004 respectively, this will only mean that 44.8 and 57.4 percent of the so-called present short-run reserves will have been utilized. But note, the price (and the cost of production) of copper will have doubled making exploration attractive and discovery, thus, more likely. Short-run reserves will consequently be added to the presently known deposits and even seabed mining must be moving closer to becoming a reality.

As to the second question, it is evident that the world copper industry is gearing up already now to meet the challenge of the 21st century with sufficient projects in place ready for the late 1980s. Let there be no doubt, the industry is looking ahead especially in the American region where not only the majority of the resources are located but also where investments are implemented to take advantage of the markets of tomorrow. The United States

and Chile, as can be ascertained right now, have decided to double copper mining output by the year 2000 such that the planning horizon is far beyond the year 1990. Canada seems to keep abreast with this drive and it means that Ontario will have to raise the output of its copper mines to 610,000 metric tons of mined copper, if it wants to hold its position as the world producer it was in 1977.

With regard to the third question, the number and the size of the processing facilities will increase. The number of concentrators, mills, smelters and refineries is going to increase. The unit capacities, too, will become larger as they have in the past when greater demands were placed upon the production structure. Technological change, especially on the metallurgical front may well accomodate the exigencies of a fast expanding copper industry. The evidence presented underscores that point.

In addition, the problem of price changes can be raised. Will the price go up? Naturally, one can be reasonably sure that it will not remain at levels experienced in the middle of the 1970s. The functioning of the market mechanism, however imperfect, stands in as a guarantor. It would be of no interest to the mining industry if today, the price of copper were, let us say, 12¢ per pound as it was during the Second World War. Industry and investments would produce anything else but copper. In turn, as the consumption demand will be there, and as the prices of most other goods will be higher the copper price must be

commensurate with the underlying equilibrium conditions;it must be higher too. And let us not forget that by the year 2000 the industry will have mined 260 million metric tons which is more than 234.5 million metric tons of copper mined since the year 1726[120] - or say 240 million metric tons since the year 1 A.D.

There a number of factors which play into the price formation besides the average grades, rising energy cost, interest rates, costs of real capital and labour. For one, there is always a spread between high and low (cut-off) grades in each and every copper producing country; furthermore, the degrees of explicit and implicit subsidization differ too among countries where they take the form of either slates of varying tax policies, concessions, incentives, rules and regulations, or the form of compulsory production goals regardless of profitability as undertaken in centrally-planned economies.[121] Finally, there is the factor which affects pricing behaviour outside the purely economic factors to which the analysis addressed itself. One has to do with the certainty of events and the circumstances that surround them. The more the scare-drum of scarcity is being stirred the more likely the unsettling effects on the behaviour of prices. Or take the situation when certainty about copper supply returned to a state of relative normalcy, be it with the Rhodesian crisis, or any other event putting an end to a period of uncertainty -in which copper is involved - the market price of copper begins to fall.

Finally, has the price of copper over time stayed constant, especially in the last decade when consumption soared? The answer is «no». The price of copper will rise as determined by the strength of the functional relationships of the main economic variables subject to the underlying conditions specified by the assumptions made for the econometric model.

The rate of growth of mined copper will not be uniform in all countries. Some countries, such as those in South America will undoubtedly make greater production contributions than those to be expected by the Middle East region. However, the heavily consuming and importing countries will try to substitute imported copper from their own mines, some of which still will have to be discovered. According to their successes, the domestic demand will be met from domestic resources, with possible spill-overs into the export market. In this sense, competition will affect the rates of growth of demand for mined copper of the main copper mining countries negatively such that their expansion rates may be modified, but is is questionable whether such future import substitution will reduce the demand for mined copper by the main producing countries in absolute terms.

NOTES

1 The scientific symbol is Cu; its atomic weight is 63.546, its specific gravity 8.93 (Fay) and it has a melting point of 1,083°C while the boiling point stands at 2,595°C. Frequency of occurrence is about 70 ppm.

2 The following items are the most important brass and bronze alloys: tin, bronze, leaded red brass and semi-red brass, high leaded-tin bronze, yellow brass, nickel silver, manganese bronze, aluminum bronze, silicon bronze, condustor bronze, copper-base hardeners and master alloys. The following quantities were produced in the United States between 1963 and 1978.

Year	Metric Tons	Year	Metric Tons
1963	263,498	1971	243,321
1964	283,147	1972	253,937
1965	298,425	1973	258,082
1966	314,914	1974	237,281
1967	281,141	1975	170,770
1968	286,741	1976	207,456
1969	291,516	1977	221,511
1970	234,722	1978	216,745

Source: same as Table 1; p. 91, cf. p. 93. Note: there is an obvious decline of production of copper alloys

3 This recovery in the United States continues into 1979. Cf. ABMS, Non-ferrous Metal Data, 1979, New York, N.Y. 1980, p.12.

4 Especially ores in the southern Unites States have impurities such as arsenic. Also, companies which toll-refine have to accept ores of relatively low qualities. This stands in contrast to the Sudbury copper production of cathode copper and wire bars which are among the purest copper products and known for that in the industry. (Courtesy: Dr. Paul Lindon, Director, School of Engineering, Laurential University, formerly of Falconbridge Nickel Mines).

5 ABMS., ibid.

6 For the econometric analysis of copper see Ch. I, p. 25, 35, 36 and Figure 7, p. 44, and Figure 8, p. 45.

7 See Ch. VII, «Nickel» p. 17-20.

8 See ABMS., ibid. p. 12.

9 For the proper estimates of these parameters see Ch. I, p. 25, and Figure 7, p. 44.

10 See «Technical Information Paper, No. 2», p. 1-2; On the Canadian scene, it is British Columbia which is in first place of the copper mining provinces with 44.5% over Ontario with 28.72% followed by Quebec and Manitoba with 12.53% and 9.19% respectively.

11 The refining capacity of the United States was estimated at 725,800 metric tons for the year 1973. The smelting capacity of the United States (H.J. Schroeder, «Copper». Mineral Facts and Problems, U.S.B.M., Washington, 1975, p. 296, Table 1) when expressed in terms of output and not load capacity, was 752,976 metric tons; this compares to the load capacity of the U.S.A. of 1,814,400 metric tons; V.V. Strishkov, «Soviet Union», M.A.R., 1980, p. 593 places the probable smelting capacity of the U.S.S.R. for January 1978 at 1.12 million metric tons (13 smelters); no refining capacity stated. The Chinese annual smelting-refining capacity is about 300,000 metric tons; see K.P. Wang,«China», M.R.A., p. 446.

12 M.G. Fleming, «Man and Minerals - A Viable Contract», the tenth Sir Julius Wernher Memorial Lecture, Proceedings of the Tenth International Mineral Processing Congress, Institution of Mining and Metallurgy, London, 1973,Alden Press (Oxford, 1974), xviii.

13 n. 1

14 Comparability is assured since Derry's reserve assessments are based on the same source as column (2).

15 The current price rose from 68.97¢/lb (1974) to 93.33¢/lb (1979) or by 35%; the price in constant 1979 U.S. dollars fell from 98.06¢/lb (1974) to 93.33¢/lb.

16 See Wang, ibid.

17 See Ch. VII., esp. p.50 ff.

18 Cf. ibid.

19 The official Canadian reserves of copper on January 1, 1980 amounted to:

('000) metric tons

1980	16,369 and for the previous years
1979	15,840
1978	16,471
1977	16,634
1976	16,803
1975	17,048

Source: W.H. Laughlin, Canadian Reserves, Energy, Mines, and Resources, Ottawa, 1980, Bulletin, MR 189.

For an explanation of the discrepancies between these reserves and those of Table 9, see the discussion in the Report on «Nickel», Ch. VII, p. 38, 39.

20 These tables are almost verbatim taken from the January issues of the Engineering and Mining Journal, 1981, 1980 and in certain cases for 1979. Their availability is herewith gratefully acknowledged. Values, where necessary, have all been translated into metric tons - except for Poland - and investment figures where available are all expressed in 1979 U.S. dollars. Other sources consulted were IMMR., 1980, op. cit., p. 335; cf. ABMS., op. cit., p. 26, 29, 32.

21 Engineering and Mining Journal, April 1981, p. 186.

22 Engineering and Mining Journal, May 1981, p. 158.

23 Engineering and Mining Journal, April, 1981, p. 185.

24 op. cit. February 1981, p. 81.

25 Vekol Copper Mining of Vekol, Arizona, had applied for approval to the Department of the Interior to build a mine and a concentrator to produce 18,100 metric tons of ore per day. Besides copper this orebody contains molybdenum, gold and silver.

26 Engineering and Mining Journal, December 1980, p. 37.

27 Francis S. O'Kelly, «Argentina», M.A.R. 1980, op. cit.,p. 395.

28 ibid.

29 Engineering and Mining Journal, February 1981, p. 151.

30 ibid.

31 The Engineering and Mining Journal, December 1980, p. 122, reports on a change in the provincial law of San Juan province, the site of the El Pachon deposit. This law

«will expand concessions to mining companies and investors, complementing the recently enacted national mining promotion law. The province will offer additional tax breaks, technical assistance, geological studies, and the construction of access roads to both Argentina and international sponsors of mining projects. Exemptions of up to 100% are available on provincial property, gross income, stamp, vehicle and electricity taxes up to 10 years. Exemptions are based on the use of local materials, exports, and employee benefits. The provincial law applies to research, prospecting, exploration, exploitation, and mineral processing by companies that diversity or expand production, or initiate mining activities in San Juan province.»

32 Frances Alves, «Brazil», M.A.R., 1980, p. 400.

33 Engineering and Mining Journal, March 1981, p. 222.

34 Frances Alves, ibid., p. 401.

35 E. Schiller, «Colombia», M.A.R. 1980, p. 405.

36 Engineering and Mining Journal, December, 1980, p. 130.

37 Ecuador which is rich in mineral deposits has not been opened up at all. However, with the assistance of the U.N. this lethargic mining situation may eventually change for a more productive era.

38 According to official statistics of the Chilean Copper Commission output of fine copper rose to 1067.7 thousand metric tons in 1980 from 1061 thousand metric tons in 1979. This last figure differs from the one used for the study. Cf. also. EMJ, May, 1981, p. 168.

39 op. cit. January 1981, p. 139.

40 J.A. Clay, «Copper», M.A.R. 1980, p. 45.

41 «Codelco and private sector will invest heavily in Chilean copper», Engineering and Mining Journal, December 1980, p. 37, 39.

42 ibid.

43 ibid.

44 F.S. O'Kelly, «Chile», M.A.R. 1980, p. 403.

45 Engineering and Mining Journal, March 1981, p. 15.

46 «PD's Munroe is optimistic about U.S. copper industry in the 1980s», Engineering and Mining Journal, December 1980, p. 27. To comment: not only U.S. corporate giants such as EXXONN, Asarco, Phelps Dodge, Newmont Mining and Utah International are seeking foreign grounds for mining operations. Canadian firms have done so, and the Japanese have long understood the economics of global mineral exploitation. In economic terms, such activities improve the overall efficiency that has been preached by J.S. Mill over a hundred years ago, but it destroys the basic premise of the very same international trade theory which is based on the existence of nations and their national enterprises (the author).

47 Note that Chile's consumption of refined copper amounted to 4.5% of mined copper.

48 J.E. Philpott, «Peru», M.A.R., 1980, p. 409.

49 IMMR 1980, p. 292.

50 Philpott, ibid, p. 411.

51 ibid.

52 ibid.

53 Engineering and Mining Journal, April 1981, p. 198.

54 M.A.R. 1980, p. 566-567.

55 H. Albarraque, «Portugal», M.A.R. 1980, p. 565.

56 Manuel Rodriguez Lopez and D. Herminio Blanco Pina, «Spain», M.A.R., 1980, p. 565.

57 Engineering and Mining Journal, April 1981, p. 200.

58 M.A.R. 1980, p. 613.

59 ibid.

60 ibid., p. 607

61 IMMR, 1980, p.

62 Engineering and Mining Journal, vol. 178, no. 2, February 1977, p. 22.

63 op. cit., January 1981, p. 65.

64 op. cit., March 1981, p. 48.

65 IMMR, 1980, ibid.

66 A.F. Westergard, «Bucim Copper Project», Engineering and Mining Journal, May 1981, p. 77.

67 Karl Lavrencic, «Yugoslavia», M.A.R., 1980, p. 613.

68 Westergard, ibid., p. 69.

69 ibid.

70 Lavrencic, bidi; the Bor complex will also extract silver, gold, platinum, palladium, vanadium and last, but not least, rhenium; reportedly this will place Yugoslavia at the top of the world rhenium producers.

71 The following discussion is essentially patterned according to V.V. Strishkov, «Soviet Union», M.A.R., 1980, the sub-section on 'copper', p. 593-595.

72 ABMS, op. cit. p. 10.

73 Strishkov, ibid., p. 597, Table B.

74 ibid., p. 593.

75 Andrea M. Radigan, «Cameroon», M.A.R., 1980, op. cit., p. 533.

76 Quansimi, Tazalaght Tanfit and Tamrift (closed 1978; also Bou Skour, and Taalat N'Ouaman).

77 Vivien Bright, «Morocco», M.A.R., 1980, op. cit. p. 539.

78 The Prieska sulfide deposits is 32 feet wide and 6,000 feet long.

79 This is based on the argument of IMMR, 1980, p. 99 whereas M.A.R. 1980, p. 491 speaks of an expansion project in connection with Foskor, which would expand open-pit operations from 1992 to 1997.

80 M.A.R., 1980, p. 493.

81 op. cit., p. 521.

82 ibid.

83 ibid.

84 Engineering and Mining Journal, January 1981, p. 143, with a smelting capacity to handle 14,000 metric tons per day (ore).

85 op. cit., February, 1981, p. 155.

86 Cf. M.A.R., 1980, p. 515.

87 ibid., p. 547.

88 Engineering and Mining Jounral, January 1979, p. 98.

89 M.A.R., 1980, p. 549.

90 J.A. Clay, loc. cit., p. 45.

91 M.A.R., ibid., p. 549.

92 Dr. Aviam Heidecker, «Israel», M.A.R., 1980, p. 544.

93 ibid.

94 Clay, loc. cit.

95 M.A.R., 1980, p. 547.

96 C.R. Neary, «Oman», M.A.R., 1980, p. 548.

97 ibid.

98 op. cit. p. 546.

99 Main reference: K.P. Wang, loc. cit., n.11, supra, p. 446-447, and the parallel article in IMMR 1980 p. 498-500, by the same author.

100 G.R. Seshadri, «India», M.A.R., 1980, p. 461.

101 S.A. Bilgrami, «Pakistan», M.A.R., 1980, p. 464.

102 ibid.

103 T.F. Lanz, D.J. Bath, «Australia», M.A.R. 1980, p. 423 cf. Clay, loc. cit., p. 45 who places the capacity of the new mine at 1,000 metric tons. Note also that the other minerals of the mine are more important, viz: Pb 7%, Zn 12.5%, 171 g/t of silver, and 3.4 g/t of gold

104 Engineering and Mining Journal, April 1981, p. 206.

105 It is difficult to allocate the exact amount which would go to the production of copper out of these $1 billion without further information.

106 See Ir. Archmad Prijono m.i., «Indonesia», M.A.R., 1980 p. 470-471.

107 ibid.

108 ibid.

109 A.F. Disinis, «The Philippines», M.A.R., 1980, p. 486. Note also the tax incentive granted to marginal mines in the Philippines, EMJ, December 1980; p. 127.

110 Clay, ibid.

111 Engineering and Mining Journal, July 1980, p. 61.

112 ibid.

113 M.A.R., 1979, p. 407.

114 ibid.

115 Assuming an annual ore tonnage extracted of 20 million metric tons would provide 100,000 metric tons of copper per year, such that Papua New Guinea's capacity would increase by 50 percent. This is a rough computation in lieu of documented evidence.

116 «Slower Growth Projected for Mining», Engineering and Mining Journal, January 1978, p. 63.

117 Schroeder, loc. cit., p. 306, Table 8.

118 ibid.

119 «Exxon unveils ambitious oil shale plan for the north-western Colorado», EMJ July 1980, p. 47.

120

Period	'000 metric tons	Period	'000 metric tons
1726-1769	137.1	1870-1919	24,456.9
1770-1800	200.0	1920-1969	133,409.9
1801-1819	291.6	1970-1976	50,850
1820-1869	2,603.0	1977-1979	23,830 (Table 4)

Tabulated from: Christopher J. Schmitz, World Non-ferrous Metal Production and Prices, 1700-1976, Frank Cass, 1979, p. 61-77.

121 The international trade economist would argue that, from the point of view of the Western consumer, such subsidization will lead to lower real incomes in those countries which initiate the subsidy program, and it may lead eventually to lower prices of the subsidized commodities on the world market due to substantial increases in quantities supplied; this may mean that the deprived consumers in the other hemisphere are forced implicitly to subsidize the consumer outside the hemisphere who will benefit therefrom. The dialect materialist does not see it in this way. Note: The consumer welfare arguments are outside this framework of reference of this industry study however interesting this whole area is for the welfare economist.
With respect to the various policies in support of copper production, it has been reported that the West German copper producers' loss in copper exports sales was artificially created by the producers in Spain, Japan, Taiwan, South Korea and other East Asian countries.
This has been maintained by a study of the Hamburg Technological Research Institute which stated that these producers are shielded from price competition in the world market by protective tariffs and their governments' tolerance of standard producer prices. This study was commissioned by the German Non-Ferrous Metal Association and it maintains that these measures «reduce processing costs for copper producers in those countries and allow them to underprice German producers and to negotiate more advantageous ore supply contracts.» Metals Week, March 24, 1980. p. 5.

Appendix

Table A1

Distribution of World Refined Copper Consumption

by Main Consuming Country

	A M E R I C A		
	% 1950	% 1979	Δ *) 1979:1950
U.S.A.	46.8	22.6	178.5
Canada	3.7	2.5	253.2
Mexico	0.4	1.0	1,009.1
Argentina	0.1	0.3	1,820.5
Brazil	0.8	2.3	1,060.4
Chile	0.7	0.5	250.7
	52.5	29.2	
		0.3	

*) = factor of change; it means

$$\frac{\text{Consumption of 1979}}{\text{Consumption of 1950}}$$

In Table A1, this value is multiplied by 100. To obtain the percentage change, subtract 100. In Tables A2, A3, and A5, at first deduct 1.0 and then multiply by 100.

Table A2

Copper Consumption of Europe as Part of World Distribution by Main Consuming Countries for the Years 1950 and 1979

	1950	1979	Factor of Δ1979:1950
	%	%	
Austria	0.1	0.2	9.33
Belgium	2.2	3.2	5.44
Czechoslovakia**	0.1	0.9	(3.152.2)
Denmark	0.2	0.03	1.02
Finland	0.3	0.4	5.17
France	4.3	3.5	3.02
West Germany	6.8	8.5	4.6
Hungary	-	0.3	(not comparable)
Italy	2.3	3.1	4.92
Netherlands	0.4	0.3	2.89
Norway	0.2	0.1	1.19
Poland*	0.1	1.9	(91.12)
Portugal	0.02	0.2	26.35
Spain	0.3	1.3	15.97
Sweden	1.8	0.1	2.23
Switzerland	.6	0.2	1.29
United Kingdom	12.8	5.1	1.46
Yugoslavia	0.7	2.1	11.08
	33.2**	30.2**	

Source: ABMS. Non-ferrous Metal Data, 1979, and Yearbook 1951 (1950), New York, N.Y.

*) shipments into Poland only

**) due to rounding, these totals of 33.2 and 30.2 differ slightly from the summary subtotals for total Europe in Table 3

**) shipments into Czechoslovakia

Table A3

Copper Consumption of Asia

World Distribution by Main Consuming Countries for the Years 1950 and 1979 & Increase over Time

Country	1950 %	1979 %	Δ 1979:1950
India	1.2	0.5	1.64
Japan	2.4	13.2	20.37
Other Asia[1)]	0.2	5.9	91.37[2)]

Source: See Table

1) Iran, Philippines, Republic of Korea, Taiwan, Turkey, China (estimated) plus other Asia.

2) From 6,315 metric tons in 1950 to 577,006 metric tons in 1979. (Korea: 93,998 metric tons, Taiwan: 73,604 metric tons, Turkey: 17,873 metric tons, Mainland China and other Asia: 374,079 metric tons.)

Table A4

Copper Consumption of Africa

World Distribution for the Year 1979 for Main Consuming Countries[2)]

Country	1979
Algeria	0.04
Egypt	0.08
South Africa	0.64
Rhodesia	0.05
Zaire	0.01
Zambia	0.01
Other Africa	0.02
	0.85[1)]

In 1954, the consumption of refined copper in South Africa was 14,300 metric tons compared to 62,827 metric tons in 1979, an increase by a factor of 4.39

Source: See Table A1

1) Due to rounding in Table the value is 0.9 and not 0.85 as this table produced to greater precision

Table A5

Copper Consumption of Australasia

by World Distribution for the Years 1950 and 1979

Country or Area	1950	1979	Δ 1979:1950
Australia	0.7	1.2	6.98[1)]
New Zealand[2)]	(n.a.)	(non-comparable)	

1) 1950 showed a 10 percent decline in consumption over the previous year, such that this factor of 6.98 is upward biassed; computing 1979:1949 values would give an increase by 6.3

2) In 1979, Australia consumed 124,211 metric tons while New Zealand consumed 1,761 metric tons of copper

Table A6

Consumption of Copper

By Centrally planned Economies (n.e.s.) for the year 1979

in metric tons and percentage Distribution of World Consumption

	metric tons	%
Albania	5,958	0.06
Germany, G.D.R.	118,073	1.21
Rumania	63,550	0.65
U.S.S.R.	1,323,268[1)]	13.5[2)]

1) This is an increase from over 219,627 metric tons, or by a factor of 6.03

2) In the year 1950, the world share of copper consumed for the U.S.S.R. was 8.31 percent.

Table A7

Copper in Ores, Concentrates and Matte

(commodity 253-10)

	Quantity (MT) Exports	Value ($'000) Exports
1979	318,347	486,864
1978	282,162	279,910
1977	279,509	273,692

1977 -	Japan	74%
	U.S.A.	7%
	Norway	7%
	U.S.S.R.	2%
1978 -	Japan	76%
	U.S.S.R.	7%
1979 -	Japan	73%
	Norway	6%
	U.S.S.R.	6%
	Spain	5%

Table A8

Copper in Slag, Skimmings and Sludge

(commodity 253-20)

	Quantity (MT) Exports	Value ($'000) Exports
1979	243	115
1978	66	26
1977	243	50

1977 -	U.S.A.	84%
1978 -	U.S.A.	82%
1979 -	U.S.A.	100%

Table A9

Copper Scrap

(commodity 253-30)

	Quantity (MT)			Value ($'000)		
	Exports	Imports	Balance	Exports	Imports	Balance
79	15,875	26,527	(-)10,652	28,385	34,953	(-)6,573
78	16,891	19,953	(-) 3,062	17,658	21,335	(-)3,677
77	16,764	11,829	4,935	18,324	11,849	6,475

Exports	1977 -	U.S.A.	61%	Imports	1977 -	U.S.A. 99%
		S. Korea	12%			
	1978 -	U.S.A.	53%		1978 -	U.S.A. 99%
		S. Korea	16%			
	1979 -	U.S.A.	75%		1979 -	U.S.A. 99%
		S. Korea	9%			

Table A10

Brass and Bronze Scrap

(commodity 253-50)

	Quantity (MT)	Value ($'000)
	Exports	Exports
1979	16,359	23,209
1978	18,695	18,463
1977	16,556	15,780

Exports	1977 -	U.S.A.	69%
		Japan	11%
	1978 -	U.S.A.	52%
		Japan	17%
	1979 -	U.S.A.	55%
		Bel-Lux	15%
		India	9%

Table A 11

Copper in Ores and Concentrates

(commodity 253-39)

		Quantity (MT) Imports	Value ($'000) Imports
	1979	2,640	3,248
	1978	18,398	17,659
	1977	4,605	3,152
Imports	1977 - U.S.A. 73%	1978 - Chile 51%	1979 - U.S.A. 88%
		Peru 26%	
		U.S.A. 19%	

Table A 12

Copper Alloy Scrap N.E.S.

(commodity 253-90)

		Quantity (MT) Exports	Value ($'000) Exports
	1979	8,163	9,035
	1978	5,610	4,662
	1977	3,777	2,772
Exports	1977 - U.S.A. 61%	1978 - U.S.A. 60%	1979 - U.S.A. 38%
			Bel-Lux 37%

Table A 13

Copper Alloy Scrap

(commodity 253-99)

		Quantity (MT) Imports	Value ($'000) Imports
	1979	8,916	8,754
	1978	7,586	6,212
	1977	3,765	3,147
Imports	1977 - U.S.A. 95%	1978 - U.S.A. 99.9%	1979 - U.S.A. 99%

Table A 14

Copper, Refinery Shapes

(commodity 452-04)

	Quantity (metric tons)			Value ($'000)		
	Exports	Imports	Balance	Exports	Imports	Balance
1979	191,125	32,541	158,584	469,267	73,901	395,366
1978	247,732	21,439	226,293	393,748	37,682	356,066
1977	294,244	18,819	275,425	430,534	28,560	401,974

Exports	1977 -	U.S.A.	30%	Imports 1977 -	U.S.	50%
		U.K.	28%		Bel-Lux	18%
		West Germany	12%			
	1978 -	U.K.	28%	1978 -	U.S.	54%
		U.S.A.	26%		Chile	32%
	1979 -	U.S.	37%	1979 -	U.S.	60%
		U.K.	29%		West Germany	25%

Table A 15

Copper Bars, Rods and Shapes NES

(commodity 452-08)

	Quantity (metric tons)			Value ($'000)		
	Exports	Imports	Balance	Exports	Imports	Balance
1979	11,665	800	10,865	30,739	1,810	28,929
1978	12,653	2,089	10,564	22,746	2,579	20,167
1977	12,822	2,397	10,425	20,951	4,052	16,899

Exports	1977 -	Venezuela	19%	Imports	1977 -	U.S.A. 76%
		Pakistan	19%			U.K. 22%
		Iran	17%		1978 -	Chile 48%
		U.S.A.	16%			U.S.A. 20%
	1978 -	U.S.A.	35%		1979 -	U.S.A. 71%
		Vanazuela	20%			West Germany 21%
		Bangladesh	13%			
	1979 -	U.S.A.	45%			
		Venezuela	14%			
		Pakistan	13%			

Table A 16

Copper Plates Sheet and Flat Products

(commodity 452-12)

	Quantity (metric tons)			Value ($'000)		
	Exports	Imports	Balance	Exports	Imports	Balance
1979	6,753	1,117	5,636	21,696	3,603	18,093
1978	6,714	1,016	5,698	17,023	2,482	14,541
1977	6,126	913	5,213	14,287	2,146	12,141

Exports	1977 - U.S.A.	94%	Imports 1977 - U.S.A.	60%
			U.K.	22%
	1978 - U.S.A.	97%	1978 - U.S.A.	52%
			Sweden	30%
	1979 - U.S.A.	96%	1979 - U.S.A.	63%
			Sweden	20%

Table A 17

Copper Pipe and Tubing

(commodity 452-15)

	Quantity (metric tons)			Value ($'000)		
	Exports	Imports	Balance	Exports	Imports	Balance
1979	9,731	2,385	7,346	30,712	8,099	22,613
1978	8,684	1,985	6,699	21,529	5,556	15,973
1977	7,514	2,187	5,327	16,762	5,366	11,396

Exports	1977 - U.S.A.	56%	Imports 1977 - U.S.A.	48%
	West Germany	17%	Japan	39%
	Israel	8%	1978 - U.S.A.	47%
	Spain	7%	Japan	36%
	1978 - U.S.A.	69%	1979 - U.S.A.	48%
	Israel	11%	Japan	46%
	1979 - U.S.A.	56%		
	West Germany	10%		
	Israel	10%		

Table A 18

Copper Wire and Cable, Not Insulated

(commodity 452-18)

	Quantity (metric tons)			Value ($'000)		
	Exports	Imports	Balance	Exports	Imports	Balance
1979	1,476	1,710	(-)234	3,114	5,096	(-)1,982
1978	1,333	1,974	(-)641	2,514	3,616	(-)1,102
1977	418	1,313	(-)895	706	3,848	(-)3,142

Exports 1977 - U.S.A. 57%

1978 - Saudi Arabia 83%
U.S.A. 16%

1979 - U.S.A. 62%
Saudi Arabia 37%

Imports 1977 - U.S.A. 96%

1978 - U.S.A. 99%

1979 - U.S.A. 95%

Table A 19

Copper Alloy Shapes and Sections

(commodity 452-19)

	Quantity (metric tons)			Value ($'000)		
	Exports	Imports	Balance	Exports	Imports	Balance
1979	12,855			35,578		
1978	14,532			31,905		
1977	11,169			22,851		

Exports 1977 - U.S.A. 98%

1978 - U.S.A. 99%

1979 - U.S.A. 97%

Table A 20

Copper Powder

(commodity 452-23)

	Quantity (metric tons) Imports	Value ($'000) Imports
1979	569	1,737
1978	710	1,775
1977	604	1,321
Imports	1977 - U.S.A. 83%	
	1978 - U.S.A. 85%	
	1979 - U.S.A. 87%	

Table A 21

Copper Alloy Refinery Shapes, Bars

(commodity 452-75)

	Quantity (metric tons) Imports	Value ($'000) Imports
1979	9,816	22,863
1978	9,940	17,802
1977	8,089	14,413
Imports	1977 - U.S.A. 82%	
	1978 - U.S.A. 75%	
	1979 - U.S.A. 80%	

Table A 22

Brass Plates, Sheet, Strip, etc.

(commodity 452-76)

		Quantity (metric tons)	Value ($'000)
		Imports	Imports
1979		4,200	9,951
1978		4,387	8,520
1977		3,815	7,431
Imports	1977 - West Germany	32%	
	U.K.	30%	
	U.S.A.	27%	
	1978 - West Germany	33%	
	U.K.	25%	
	U.S.A.	21%	
	1979 - West Germany	41%	
	U.S.A.	40%	
	U.K.	13%	

Table A 23

Copper Alloy Plates, Sheet, etc. NES

(commodity 452-78)

		Quantity (metric tons)	Value ($'000)
		Imports	Imports
1979		1,081	4,253
1978		1,054	3,792
1977		1,432	4,497
Imports	1977 - U.S.A.	72%	1978 - U.S.A. 73%
	U.K.	19%	U.K. 10%
	1979 - U.S.A.	77%	
	U.K.	10%	

Table A 24

Copper Alloy Pipe and Tubing

(commodity 452-85)

	Quantity (metric tons)			Value ($'000)		
	Exports	Imports	Balance	Exports	Imports	Balance
1979	3,983	2,484	1,499	14,964	9,688	5,276
1978	6,225	2,491	3,734	15,341	8,164	7,177
1977	3,882	2,477	1,405	11,066	6,704	4,362

Exports	1977 - U.S.A. 72% Emirates U.A. 26%	1978 - U.S.A. 95%	1979 - U.S.A. 83% Puerto Rico 6%	
Imports	1977 - U.S.A. 71% West Germany 22%	1978 - U.S.A. 54% West Germany 30%	1979 - U.S.A. 64% West Germany 32%	

Table A 25

Copper Alloy Wire and Cable, Not Insulated

(commodity 452-88)

	Quantity (metric tons)			Value ($'000)		
	Exports	Imports	Balance	Exports	Imports	Balance
1979	169	764	(-)595	647	2,989	(-)2,342
1978	333	496	(-)163	724	1,879	(-)1,155
1977	328	592	(-)264	582	1,880	(-)1,298

Exports	1977 - U.S.A. 93%	1978 - U.S.A. 80%	1979 - U.S.A. 75%
Imports	1977 - U.S.A. 85%	1978 - U.S.A. 78% U.K. 9%	1979 - U.S.A. 78% Japan 10%

Table A 26

Copper Alloy Castings

(commodity 452-90)

	Quantity (metric tons)	Value ($'000)
	Imports	Imports
1979	582	2,457
1978	399	1,501
1977	345	1,182

Imports 1977 - U.S.A. 97% 1978 - U.S.A. 97% 1979 - U.S.A. 96%

Table A 27

Copper and Copper Alloy Fab. Mat. NES

(commodity 452-99)

	Quantity (metric tons)			Value ($'000)		
	Exports	Imports	Balance	Exports	Imports	Balance
1979	1,634	2,040	(-) 406	5,619	9,857	(-)4,238
1978	1,410	1,732	(-) 322	3,998	6,546	(-)2,548
1977	1,431	2,532	(-)1,101	4,295	7,230	(-)2,935

Exports	1977 - U.S.A. 59%	1978 - U.S.A. 54%	1979 - U.S.A. 79%	
	India 14%	Colombia 26%	U.K. 12%	
	Portugal 12%	U.K. 16%		
Imports	1977 - U.S.A. 42%	1978 - U.S.A. 66%	1979 - U.S.A. 84%	
	Sweden 27%	Nether- 13%	Sweden 3%	
	Nether- 23%	lands 9%		
	lands	Sweden		